The Pennsylvania State University

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SUSTAINABLE ACQUISITION PROCESS IMPROVEMENT FOR NAVAL FACILITIES ENGINEERING COMMAND

A Thesis in

Architectural Engineering

by

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ABSTRACT

Mandated reduction of natural resources consumed by U.S. Federal Facilities has forced agencies to reconsider how facilities are acquired. The process for acquiring federal facilities is guided by laws, executive orders, policies and regulations. While this guidance is intended to create an open and competitive process to achieve lowest cost or best value, conflicts among traditional acquisition processes and new law requirements are emerging. To meet the new requirements, laws must be implemented through effective policy. For over 6 years, the Navy has been acquiring sustainably designed facilities and has recently set sustainable development policy guidelines. To meet these new sustainable development goals, facility acquisition processes must reflect current policy mandates.

In this thesis, numerous sustainable acquisition processes are evaluated. Selected processes occurring primarily in the *Planning* and *Programming* phases of a construction project are emphasized and represent common practices used by other governmental agencies.

Through interviews and case study research, a set of feasible actions aimed to help NAVFAC achieve sustainable development goals are outlined. This thesis provides process improvement recommendations for Naval Facilities Engineering Command.

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CHAPTER ONE: INTRODUCTION

1.1. Preface

Then I say the earth belongs to each...generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence. - Thomas Jefferson, September 6, 1789

Continuing worldwide population growth and technological achievements have resulted in increased natural resource utilization. The consequences have been a depletion of natural resources; air, land and water pollution; ozone depletion; global warming; and a wide range of other consequences detrimental to the environment. As a result, the earth's ability to replenish depleted resources and provide the ingredients necessary to sustain life is being threatened (Emmons, 1998).

Operation of residential and commercial buildings in the U.S. consumed 36.4% of total U.S. primary energy in year 2000. (The rest is used by industry, 36.5%, and transportation, 27.0%–total building energy consumption is actually higher than 36.4%, as some of the industrial energy use is for cooling, heating, or illuminating industrial buildings.) (EBN 2001) Consumption of electricity in the commercial buildings sector has doubled in the last 18 years and will increase again by 25% by the year 2030 if current growth rates continue. These buildings also produce 35% of the carbon dioxide (CO_2) emissions in the U.S. (CBI 2000) and more than 25% of all greenhouse gas emissions. Furthermore, it has been estimated that construction debris accounts for over half the volume all trash in U.S. landfills (WBDG 2001).

The federal government owns approximately 500,000 buildings. This facility inventory represents an asset portfolio of more than $300 billion. Annually, more than $20 billion is spent acquiring or substantially renovating existing federal buildings. Figures indicate that in FY 1997, Federal government facilities used nearly 350.3 trillion

British Thermal Units (BTUs) of energy at a total cost of $3.6 billion. These same facilities spent over $500,000 million annually for water and sewer (FEMP 2001).

One concept aimed to manage the rate at which our natural resources are being consumed has been termed *sustainable.* The most well known definition was given by a report from the United Nation's World Commission on Environment and Development (Brundtland Commission). Directly applied to industry growth and urban development, it states that sustainability is " Meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Razili 1987).

1.2. Introduction to Naval Facilities Engineering Command (NAVFAC)

The Naval Facilities Engineering Command manages the planning, design and construction of shore facilities for U.S. Navy activities around the world. NAVFAC is a global organization with an annual volume of business in excess of $9 billion. Today, over 16,000 civilian and military people with in NAVFAC, manage real estate, plan construction, and administer construction contracts to provide required shore based infrastructure in support of our fleet assets.

In the summer of 1993, the Navy's Environmental Performance Standards Quality Management Board (QMB) chartered a process action team (PAT) to focus on how the Navy could demonstrate environmental leadership through careful planning and proactive commitment. While the term "sustainable" was not yet used within NAVFAC, a Process Action Team (PAT) team was steering toward changes that NAVFAC continues to explore.

In February of 1996, findings from a report from the President's Council on Sustainable Development spurred initiatives for a pilot projects program. By 1998 the NAVFAC Headquarters team was actively drafting policy to guide the regional components in efforts to realize a change in the design and programming. NAVFAC

Several government agencies and consultant firms have led most of the progress in this area through trial and error and using own lessons learned. For this reason, NAVFAC needs to evaluate their unique situation and apply existing knowledge and practices to achieve the desired end state – be able to effectively and reliably implement sustainable design and development.

Any facility's life-cycle involves a number of common stages. Planning, design, construction, start-up, operation, renewal, and finally, disposal are major stages endured by a building. Modern designs strive for, at minimum, a 30-year life, however, if appropriate maintenance and repair is performed, life expectancies can easily achieve 100 years. Of course, design and construction quality are the major factors in the service life – these qualities will have a major effect on total facility ownership costs.

The total cost of facility ownership is the sum of all expenditures over the service life of the facility. These costs include design, construction, maintenance, repairs and normal operations for the life of the building. Of the total ownership costs, the "first costs" such as design and construction represent only 5 to 10 percent. Operation and maintenance costs will range from 60 to 85 percent while land acquisition, renewal and disposal account for the remaining 5 to 35 percent (NRC 1998).

1.3. Introduction to Research Problem

The terms "sustainable design" and "green design" are used interchangeably throughout this thesis report. There lies no significant difference between the two except for a slight difference in connotation. Typically, "sustainable design" is used when referring to the nature of design that is integrated to achieve greater economic efficiencies, while "green design" is used to refer to the qualities that achieve greater environmental benefit. In the end, both economic efficiencies and environmental benefit can be achieved through good design, whether called "sustainable" or "green." The term

"High-performance building" is also frequently used. Again, this should be viewed as synonymous with sustainable or green buildings.

1.4. Problem Statement

NAVFAC Engineering Command requires information and guidance on how to effectively, uniformly, and reliably implement sustainable building processes without adversely impacting current facility acquisition processes for Design-Build, Military Construction (MILCON) projects.

The need for policy improvement has been made formal by the Chief of the Civil Engineer Corps and emphasized other executive level leadership within NAVFAC. Specific guidance has been given to review publications from Rocky Mountain Institute. Any findings or recommendations from research are to be made available for policy writers' consideration (NAVFACHQ 2000).

1.5. Scope

The nature of this research consists primarily of a qualitative evaluation of actions and processes. These processes are experienced by a typical construction project consisting of the following NAVFAC acquisition phases: Planning, Programming, A/E Selection, A/E Contract, Concept Design, Design Development, Bidding and Award, Design and Construction, Commissioning, and Turnover. The Sustainable Acquisition Process Model (SAPM) is focused on improving NAVFAC's current acquisition process by integrating additional processes or actions that have been used by other government agencies.

While this research examines the entire NAVFAC acquisition process related to sustainable development, primary focus for analysis and application of improvement

recommendations is focused on the **Planning** and **Programming** phases for Navy Military Construction Projects (MILCON), design-build delivery method.

1.6. Reader's Guide

This research addresses current building or facility acquisition practices currently employed to achieve sustainable buildings. The history that has brought NAVFAC to where it is today is discussed here in Chapter 1. Federal regulations and Executive Orders, current industry practices, as well as, the current NAVFAC policy and processes will be examined in Chapter 2.

While the topic of this research is relatively new, little data exists in the industry that maps the design process of sustainably built facilities. Best practices have not been solidly established and many entities are conducting business in similar fashion without the benefit of sharing knowledge. Chapter 3 will present the research methods chosen to conduct this research.

The need to understand the environment in which this research focuses is described in Chapter 4. Here a model has been developed to map the acquisition processes currently used by NAVFAC for design-build, MILCON projects. This model will also serve as the platform to present the results from this research.

Chapter 5 proposes process improvements to the already existing acquisition model in the form of action items timed to achieve greatest benefit in the planning and programming phases. To assess, corroborate and validate these proposed improvements, several techniques including case study analysis are presented in Chapter 6. Chapter 7 displays the recommendations that will be presented to NAVFAC for possible implementation and sustainable development policy guidance. And Chapter 8 draws conclusions and identifies required future research.

CHAPTER TWO: BACKGROUND OF SUSTAINABILITY

2.1. Scope of Review

The subject of sustainable building design is relatively new. Before 1987, the definition of sustainability as it relates to building design did not exist. Almost all of the literature written on the subject has been produced in the past 5-7 years, and most of that within the past two years. Journal research has been conducted resulting in no research articles found related to sustainable building design. There are, however, many recent guides, magazine articles and papers that provide useful information. Many federal, state and city agencies are developing sustainable building programs and have documented these results. Consulting agencies are also beginning to provide sustainable design guidance and services.

The purpose for this review is to identify and summarize existing opinions, fact and drivers for the improvement of the sustainable design processes. While many research and development efforts have been aimed to create and improve specific sustainable strategies and technologies, very little work has been done to identify processes in which these strategies are effectively implemented. For example, the angles, location and dimensions for light-shelves to improve day-lighting has been extensively researched and tested. However, if the most basic consideration of building orientation and location is not addressed at the right time in the planning phase of a project, the sought benefit of natural lighting may be lost or minimized. Through careful review, process improvements will be separated from specific strategies and state-of-the-art technologies used in sustainable development.

This literature review is arranged into four areas. With the results of this research being applied to a large government agency, government policy driving changes in practice will be summarized. Guidance from the President in the form of Executive Orders and legislation in the form of regulations has been the catalysts for change.

Private industry designers, engineers, consultants and research institutions have pioneered the development of sustainable design and building practices. Several predominate sources will be discussed to show how separate corners of AEC industry are realizing a consensus on some methods for achieving sustainable buildings.

Other Department of Defense agencies such as the Air Force and Army are acquiring sustainably designed facilities as well. While their acquisition processes are similar to the Navy's, their construction and contract management components differ significantly. Processes being currently used by these agencies are reviewed.

In order to effectively apply this research to existing Navy practice, current processes utilized by NAVFAC will also be summarized. Policy statements and formal Navy instruction have been reviewed to show the need for continued process improvement related to sustainable design. Furthermore, research results will be directly applied to the existing processes resulting in future policy revision.

The ability to affect the design and construction process changes with time. Classic level of influence research supports the need to address design requirements as early as possible in the project life cycle – this concept may be directly related to the ability to achieve greater sustainability in facility acquisition.

2.2. Government Policy and Guidance

The Department of Energy's (DOE) Greening Federal Facilities is a resource guide intended for federal facility managers. This guide highlights actions that facility planners, managers, and design staff can take to save energy and improve the working environment. In addition to this guidance, it provides some of the orders, legislature and regulations that are driving these sustainable design efforts.

There have been 12 executive orders issued related to sustainable design initiatives since the first in April 1991. The first of these orders required a 20% energy reduction in federal facilities compared to a 1985 baseline. Since then orders have been issued addressing use of energy efficient vehicles, use of bio-based materials, green procurement guidelines, waste prevention, use of non-ozone depleting substances and use of material recycling programs. Probably the most direct and challenging order was issued by the President in June 1999. Executive Order 13123, Section 403(d), instructs Federal agencies to develop sustainable design principles and use them in the planning and building of new facilities. The Chief of the Civil Engineer Corps's order includes reduction of greenhouse gases by 30% from 1990 levels by year 2010, reduce energy consumption by 35% by 2010 (from 1985 levels) and increase water conservations and cost-effective use of renewable energy (FEMP 2001).

The first of the Federal laws was the Energy and Conservation Act of 1975. This was the first piece of legislation that directed Federal energy management to take specific action. Since then, several acts have mandated recycling programs, required life-cycle analysis (LCA) as basis for energy procurement, provided alternative funding sources for energy-efficient investments via "shared energy savings" (SES) contracts. The last of these laws was passed following the 1991 executive order, the Energy Policy Act of 1992 (EPACT). This law, in addition to requiring the 20% energy reduction, provided DOE the ability to issue guidance on Energy Savings Performance Contracts (ESPC) for Federal agencies. It also required the General Services Administration (GSA) to report annual energy costs from leased space.

Some regulations have been added to the Federal Code (CFR) as well. Section 10, Parts 435-6 establish design criteria for Federal commercial and multifamily high rise buildings as well as directing procedures for life-cycle cost effectiveness of energy conservation in retrofits of existing buildings (FEMP 2001).

In the commercial construction industry the market, design trends, and other factors may play an important roles in the determination to how sustainable a building should be designed. However, the Federal facilities managers have specific drivers such as laws, orders, and regulations that mandate that sustainable design be implemented in our new and renovated buildings.

DOE's Greening of Federal Facilities Guide is divided into 9 subsequent parts. Most parts pertain to sustainable strategies and technologies that can be applied and when applied, may help managers conform to the preceding mandates. One section that will be most helpful deals with environmental and energy decision making. This part highlights the criticality for integration in design, discusses procurement and financing practices, and reviews economic and environmental analysis to be used for support during budgeting phases of a project.

Sustainable facilities differ from their conventional counterparts – not by function or necessarily appearance, but by the *process* used during the planning, design, construction and operation of that facility. During this process, strong attention is given to ensure integrated design takes advantage of potential synergies available when combining different systems. These synergies usually equate to large scale energy savings. The following opinions summarize the experience and expertise of the authors of DOE's Greening of Federal Facilities:

- The sustainable goals for the project need to be clearly identified before beginning design. These requirements can be measured by standardized criteria. The U.S Green Building Council's LEED rating system is one example of standardized criteria. Almost as equally important is the team selection. This team requires solid experience in green design. Outside 'green' expertise maybe required, however, this demand will diminish as agencies develop their own expertise.

- During the request for proposals (RFP) for design teams, the planning team should clearly state an intention to select architectural and engineering (A/E) firms that are experienced and capable. The statement of work should, at a minimum, address the need for integrated design at every phase.

- Brainstorming sessions, or charrettes, are effective means of interdisciplinary planning and design. These charrettes are aimed to encourage "outside of the box" solutions to complex problems. Agendas and measurable goals are to be established for every meeting. Results should be reviewed and confirmed by every member of the team. Additional charrettes should be conducted according to need and level of optimizing ability. This ability to optimize should only be constrained by funding, function, environment, or time.

2.3. Current Commercial Practice

In order to describe current commercial sustainable processes, a logical progression of events has been chosen. These events consist of goal setting, project team selection, and the planning and concept design activities. These events occur early in the project's life. Much of the AEC industry's leaders in sustainable and green design have developed processes that help to achieve a project's sustainable objectives. And these objectives are being measured a common method.

2.3.1 Measurement of Sustainability

The U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system is used, almost exclusively, by the design industry as a method of measuring sustainability. LEED™ is a consensus-based, market-driven rating system that can serve both as criteria and as measurement for NAVFAC building projects. The LEED system was created to define "green building" by

establishing a common standard of measurement, promote integrated, whole-building design practices and to recognize environmental leadership in the building industry. LEED provides a framework for assessing building performance and meeting sustainability goals. The LEED system also recognizes achievements and promotes expertise in green by offering project certification, professional accreditation, training and practical resources (USGBC 2003). The LEED system does have its faults – a lack of quantitative measuring and subjective decision making by designers and LEED certification authorities make it vulnerable to criticism. LEED certification does imply extra expense for the documentation efforts.

While this rating system attempts to place a numeric value on design that makes effective, efficient use of the environment and its resources, it is not the only assessment system available. BREEAM or Building Research Establishment Environmental Assessment Method is another rating system that is popular in the UK. BREEAM is a method for assessing the environmental quality of buildings. It considers design issues that affect the global environment, local environment and the health and well being of building occupants. BREEM's primary difference from LEED is in the approach resource conservation is achieved. BREEM is much more prescriptive in materials and equipment specifications than the LEED system.

2.3.2 Goal Setting

The delivery of a high-performance, sustainable building requires significantly increased collaboration among the various professionals on the project team. A focused goal setting process will help to lay the foundation for interdisciplinary design and resources management. From this process, a action plan to achieve clear measurable objectives can be carried forward for implementation (Tormenta 1999). Stakeholder buy-in and commitment to goals is also critical. In Figure 2.1, the major factors for energy and environmental goal setting are related. These factors, in general terms, represent the project as a whole.

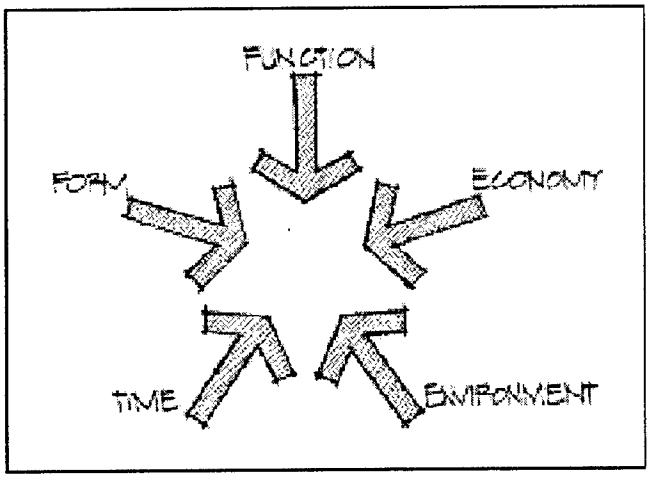

Figure 2-1. Sustainable Goal Factors (ENSAR Group)

As specific goals become more defined through an iterative process, environmental education for the whole team is essential. The key decision makers have to understand the implications of different alternatives. In addition, this team needs to be led by a "champion" or advocate that maintains the objectives in clear view. However, in order for this champion to be effective, the team must be chosen carefully (AEGBP 2001).

2.3.3 Team Selection

In contrast, integrated building design brings together all parties that will be involved in the project, working together from the start, to coordinate and optimize the design of the site and the building. It is advantageous for the team members to be fluent in the technical language of the others. Constant project communication is the foundation for this teamwork. It is also important to have one person responsible for leading the entire interactive team. The appropriate members of the team should stay involved throughout the planning and programming phases of the project. The contractor or builder should be included in the team effort early enough to effect decisions that concern assembly sequence and constructability (Hayter 2000). Some of the following stakeholders will be required team members (Prowler 2001):

- Building owner, occupants, and users

- Architect, planner, landscape architect, interior designer, engineers (all disciplines), and special consultants (e.g. acoustical)
- Contractor and sub-contractors
- Local officials
- Product manufacturers

2.3.4 Charrette Process

A design charrette is "a workshop held in a two to three-day period in which architects and other design professionals, community leaders, public officials, and citizens work together to envision alternatives for a local building program, neighborhood or regional community project, with an emphasis upon long-term economic, social and environmental sustainability." Charrettes provide an interactive forum where professionals from various disciplines can propose alternate visions and evaluate future plans for a project. These forums are critical for a team to collectively understand the complexities of a project and to effectively apply individual knowledge to create a synergistic solution – a solution that takes advantage of optimizing systems (Watson 1996).

2.3.5 Integrated Design – Whole Building Design

To proceed in the direction of integrated design for building, a collaborative approach is required. As stated earlier, this approach will include the client and other stakeholders but could also include community members and various specialty consultants. An effective method to begin the collaboration is the use of a design charrette (Prowler 2001).

Conventional building design tends to be linear with little interaction between the parties involved in the project. Many times the architect creates a design and hands it off to the engineers who design their systems and then pass the design off to the contractor. This hand-off process can leave many good ideas behind and does not allow for

coordination or optimization of systems (Prowler 2001). This conventional approach often produces problems due to this lack of teamwork that include:

- Failing to meet needs/functional requirements of the owners and occupants
- Change orders resulting in additional design costs, increased construction costs, and delayed schedules
- Decreased occupant productivity
- Poor energy performance
- Occupant discomfort
- Harmful environmental impact

Sustainable buildings are high performance buildings. To evaluate performance, the building is viewed as an integrated whole. The resource savings spread over the building's life coupled with the improved productivity of its occupants for that same time is where the performance of a green building is realized. If buildings are assembled in an integrated manner, the ability to achieve a "whole: that is greater than the sum of its parts is possible. In order for this integrated approach to design to be cost effective, the focus must be maintained on long-term net gains in efficiencies and productivity (SBIC 2002).

Through a whole building approach, sometimes referred to as "systems engineering", all of the building components and subsystems are considered together. Each of their inherent potential interactions are planned and engineered to achieve synergies. The fundamental goal is to optimize the design such that the comfort, function, efficiency, and economic return are maximized. The whole-building approach has been shown to enhance air quality and lighting, as well as, benefit the natural environment through waste reduction and effective land use (CBI 2000).

Some of the benefits of the integrated design process include:

- Minimum change orders, cost savings, and delivery to the client ahead of schedule
- Satisfies the needs/functional requirements of the owners and occupants

- Improved occupant comfort and health
- Increased occupant productivity
- Energy efficiency
- Environmental sustainability and positive environmental impact
- Low operating and maintenance costs

2.3.6 Financial Implications

Many times the misperceptions about the high cost of sustainable buildings deter owners from further consideration. However, a project developed through an integrated design approach could cost no more to construct than one developed utilizing standard design procedures. However, the integrated approach may result in additional design costs due to expenses associated with additional coordination meetings, computer modeling and consultant fees. If there are additional design costs, most often times, the additional expense is worth the benefit. For example, projects designed using the linear conventional approach often require numerous changes during construction or retrofit after it is completed. These required changes can be very costly and cause critical delays (Prowler 2001).

Another concept recently gaining credibility is called whole-system costing. This process allows for the budget of a building to be set while allowing some features to cost considerably more than conventional buildings. A high-performance building will incorporate potentially complex components such as advanced glazing, day-lighting features, efficient lighting, raised floor combined with efficient mechanical systems. An integrated design, one that effectively combines these various systems to create the optimal service capacity will result in smaller, less expensive individual systems. In other words, by minimizing the sizing of components to exactly meet the design requirements, efficiencies resulting in over all lower capital costs can be realized. Empirically, designs targeting 20-40% energy reduction are generally slightly more expensive because of higher component costs with out the ability to downsize other components. Designs

seeking 50% savings frequently cost similar to conventional designs. Designs aiming for 70-90% savings can sometimes cost less than conventional (Browning 2000).

Currently, the biggest obstacles for embracement of this approach lies in the financial markets. Most financing sources for green projects today are high net-worth individuals rather than banks or traditional investors. One challenge that still exists is the tendency for people to try and sell the sustainability itself rather than the benefits that that sustainability will provide in the short and long term. Environmentally responsible projects are more durable, economical, and efficient to operate. Additionally, the improvements to comfort and occupant health can be dramatic improvements over conventional building design.

2.4. Army Design Policy

The Army's Corps of Engineers (ACE) established specific sustainable design policy March 31, 2001. The technical letter produced by the Chief of Engineering and Construction provides basic criteria and information pertaining to the incorporation of sustainable design concepts in the design and construction of Military facilities. The appendices for this policy outline action to be taken by all ACE commands having design responsibility.

The ACE created its own sustainable measurement method called the Sustainable Project Rating Tool (SPiRiT). SPiRiT is very similar to LEED in that the same categories of design consideration are accounted for, however, military standards and self-assessment ability have been added (USACE 2001).

2.5. Air Force Initiatives and Sustainable Process Outline

In March 2000, the U.S. Air Force (USAF) contracted services for the development of a sustainable design guide. This guide was designed to provide useful process, design and resource information to aid USAF designers, facilities managers and unit commanders in their efforts to acquire facilities. It was also aimed to serve architects designing USAF facilities. Primary emphasis was placed on the importance of integrated design, pollution prevention, and energy savings.

The Guide also presents sustainable design phases, team members and action items. The main phases are sequential - Pre-design, Siting, Programming and Schematic design. In Table 2.1, the pre-construction processes are represented.

Table 0-1. USAF Sustainable Design Process

Phase	Team	Action
Pre-Design	▪ Architect ▪ Mechanical Eng. ▪ Electrical Eng ▪ Occupants ▪ Programmer	▪ Describe overall building requirements ▪ Describe project in relation to surroundings, site, climate and community. ▪ Summarize Codes, covenants, and legal restrictions and zoning. ▪ Define comprehensive list of environmental / sustainability goals.
Siting	▪ Architect ▪ Mechanical Eng. ▪ Electrical Eng ▪ Occupants ▪ Programmer ▪ Landscape Arch. ▪ Civil Eng. ▪ Community Planner ▪ Base Environmental	▪ Produce geotechnical soils report ▪ Create site environmental inventory ▪ Collect climate information ▪ ID how site effects energy ▪ ID day-lighting options ▪ ID impact of proposed structure on microclimate ▪ ID archeological, cultural and historical concerns ▪ Establish water conservation measures ▪ ID site air quality issues ▪ ID impact of structure on existing utilities infrastructure
Programming	▪ Architect ▪ Mechanical Eng. ▪ Electrical Eng ▪ Occupants ▪ Programmer ▪ Landscape Arch. ▪ Civil Eng. ▪ Community Planner	▪ Prepare listing of space requirements ▪ Develop adjacency requirements ▪ Est. lighting levels for spaces ▪ Design mechanical system energy usage ▪ Est. energy budget ▪ ID waste handling methods ▪ ID waste reduction goals during construction ▪ ID spatial needs for waste handling ▪ ID site features to be protected during construction ▪ Est. indoor air quality standards
Schematic Design	▪ Architect ▪ Mechanical Eng. ▪ Electrical Eng ▪ Occupants ▪ Programmer ▪ Landscape Arch. ▪ Civil Eng. ▪ Contractor ▪ Community Planner ▪ Base Environmental	▪ Create layout that serves client needs ▪ Optimize layout for energy consumption ▪ Design for day-lighting ▪ Choose materials appropriate to program, site, and climate ▪ ID probable construction costs ▪ Est. preliminary Life Cycle Analysis costs of materials and building systems.

2.6. Navy Policy on Sustainable Development

"It is the policy of NAVFAC to incorporate sustainability principles and concepts in the design of all facilities and infrastructure projects to the fullest extent possible, consistent with budget constraints and customer requirements." This opening statement for the first policy drafted in 1998 adopted sustainable design as an integral consideration in the facility acquisition process. Since this significant change in policy occurred, several amplifying statements have been released: (1) Requirement of the use of architect and engineer (A/E) services that are selected, in part, for their knowledge of sustainable development concepts and experience, (2) to adopt and use industry-recognized standards for codes, criteria, and measurement related to sustainable design, and (3) required use of LEED rating system for sustainable design measurement (NAVFACHQ 1998).

Today, the policy has changed slightly and is as follows, "It is the policy of Naval Facilities Engineering Command (NAVFAC) to reduce the total cost of ownership of Navy shore facilities by incorporating sustainable development concepts and principles in the planning, programming, design, construction, operation and maintenance, sustainment, restoration, and modernization of all facilities and infrastructure projects to the fullest extent possible, consistent with mission, budget (incorporating lowest life-cycle costs) and client requirements. This instruction applies to all projects, regardless of funding source, acquisition method or client. NAVFAC shall use the U. S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED™) Green Building Rating System as a tool in applying sustainable development principles and as a metric to measure the sustainability achieved through the planning, design, and construction processes" (NAVFACHQ 2003).

2.7. Current Navy Sustainable Development Process

NAVFAC Headquarters formed a working group responsible for defining the sustainable development objectives for the Navy. This group of executive level leaders from all regions of the organization was named the NAVFAC Sustainable Working Group. It is responsible for creating policy and guidance for the implementation of sustainable development.

In Figure 2-2, the basic acquisition phases are represented. This simple phase model will provide the framework for showing current sustainable processes, as well as, provide the platform to show possible improvements that may be implemented. Table 2.2 shows the sustainable processes required by current policy.

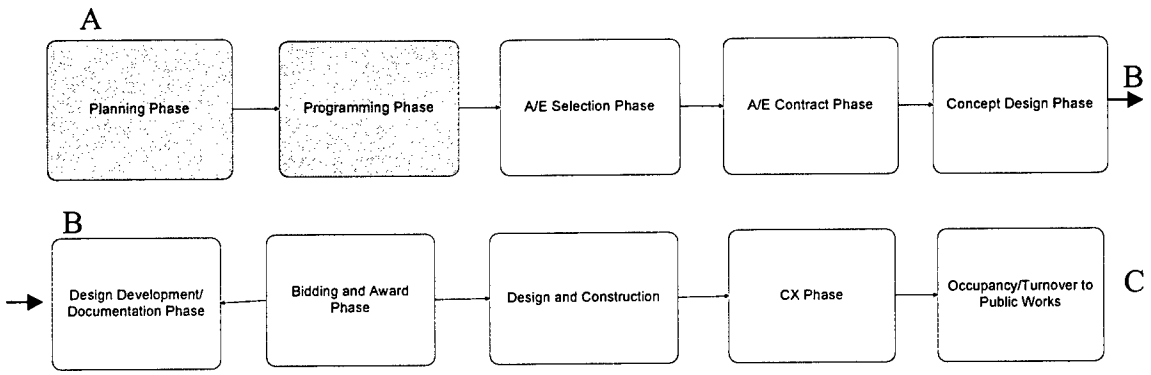

Figure 2-2. NAVFAC Acquisition Model (Two-Phase Design-Build)

Table 0-2. Current NAVFAC Sustainable Acquisition Processes

Phases	Sustainable Development Processes
Planning	▪ Determine Sustainable Goals ▪ Identify Sustainable Design Strategies
Programming	▪ Itemize Additional Sustainable Design Costs on DD1391 Form
A/E Selection	▪ Develop FBO Announcement requiring SD experience ▪ Place LEED accredited person on selection board ▪ Educate board personnel on SD concepts
A/E Contract	▪ Develop SOW for A/E services for SD goals and strategies
Concept Design	▪ Conduct Functional Analysis Concept Design (FACD) Charrette ▪ Set Sustainable Goals ▪ Begin SD Report
Design Development	▪ Perform Energy and Day-lighting Modeling ▪ Update SD Report
Bidding and Award	▪ Pre-bid conference to address SD Goals
Design and Construction	▪ Maintain SD Report ▪ Educate ROICC/KTR on SD Goals ▪ Establish waste management program
Commissioning	▪ Verify Sustainable strategies incorporate successfully during construction ▪ Validate proposed means of system performance measurement
Turnover	▪ Educate client and facility operators on SD strategies incorporated ▪ Periodically evaluate performance

2.8. Level of Influence

The opportunity for decisions to influence the cost of a facility is high during the planning and early design stages of a project. This influence decreases rapidly as the project progresses through design, construction and operation by client. Figure 2-3 graphically presents this concept.

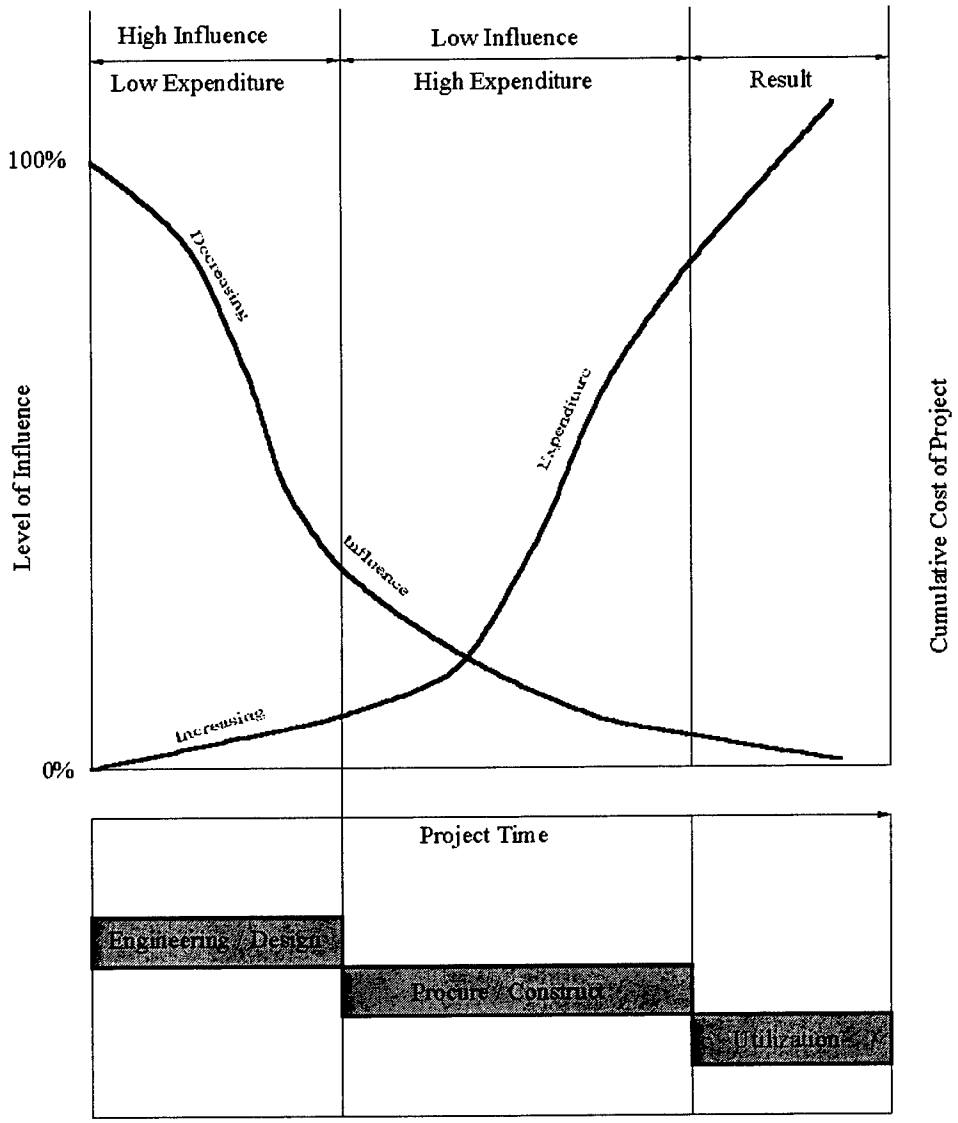

Figure 2-3. The Level of Influence on Project Costs (Paulson 1976)

The figure uses two curves to illustrate the relationship between a decision's level of influence and project cost related to that decision. The ability to influence the project decreases rapidly in the early stages of engineering/design while the cost for those decisions climbs slowly. If this model represents most construction projects, then the decisions made with respect to sustainable design will have less impact on project cost if made in the earliest stages – the earlier, the better.

Another example of a similar relationship related to energy savings and building phases is depicted in Figure 2-4.

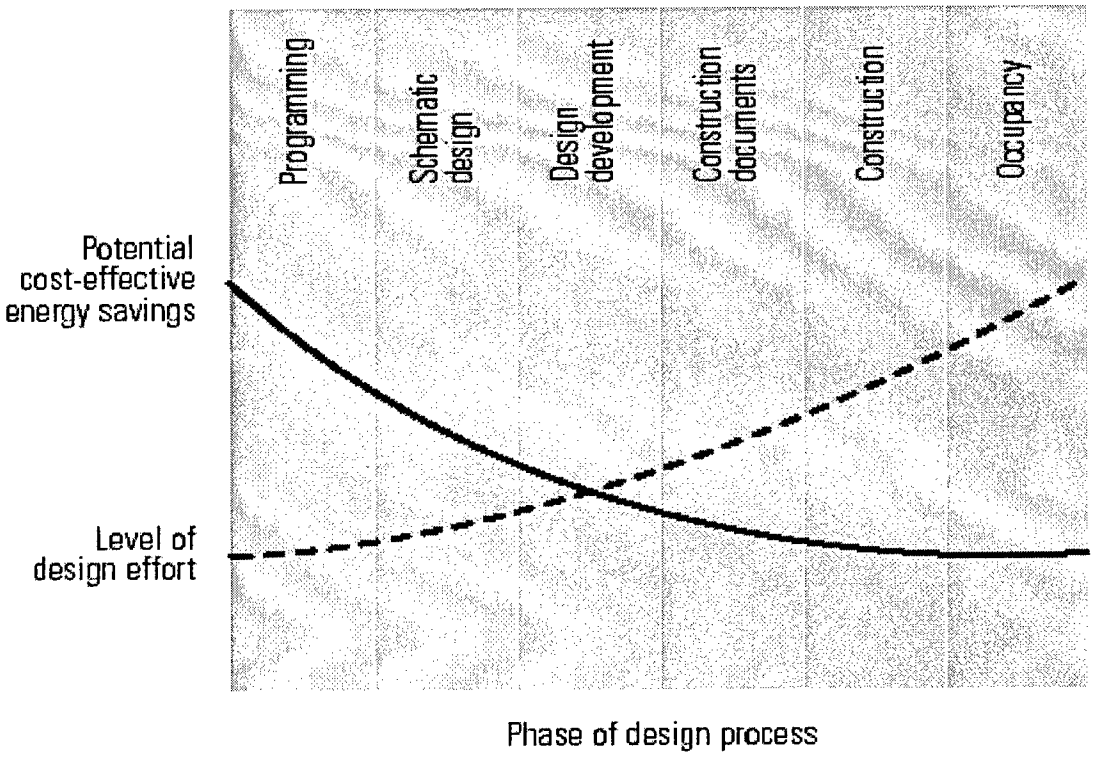

Figure 2.4. Energy-savings opportunities and the design sequence(EDR 2002).

These two curves, energy savings potential and design effort also imply that energy reduction methods and decisions made in the programming phase require less design effort to achieve. If energy consumption requirements for a building are decided at a later stage, the design effort to integrate among all other building systems is more difficult and most likely more expensive.

2.9. Acquisition Process Modeling

Acquisition processes used to construct facilities for the Navy undergo various stages before client occupancy and building operation. One method to represent essential functions, actions and decisions that must occur to acquire facility is to model the

building process. In 1990, Sanvido developed the Integrated Building Process Model (IBPM) to show all functions required to deliver a facility to the end user. The functions included managing, planning, design, construction, and operations. This model provides a framework to identify, for any process, the input, output, controls and mechanisms required to construct a building. Benefits from use of this model include the improved ability to analyze project management procedures, improve communication between project stakeholders, and for teaching purposes (Sanvido 1990).

2.10. Summary: Current State of Knowledge

This chapter described the need and main drivers for design and construction improvement in federal buildings – specifically related to sustainable development. Laws and regulations now support initiatives taken by agencies to improve the built environment for our federal workers and military personnel. These improvements are being measured by the new methods described and rated by ability to efficiently utilize natural resources and reduce waste in the acquisition of a facility.

Current commercial practices used to realize sustainable goals are also described. Many design, engineering, and communication techniques are being used to creatively meet a project's goals. These include charrettes, goal setting, and integrated design strategies that are used early in the planning and design phases.

Previous research concerning sustainable process development is unavailable. Also, a collective set of processes (and related timing) that are required to achieve sustainable buildings is not well documented. While many techniques have been demonstrated on successful projects, there exists little guidance for a complete approach to acquire a sustainable facility. In the next chapter, research methods used to build the NAVFAC Sustainable Acquisition Model (SAPM) are described.

CHAPTER THREE: RESEARCH METHODS

This chapter describes the research goal, objectives and methodology used for this study to identify process improvement candidates that may be applied to the Navy's sustainable acquisition process. The improvement candidates (IC) selected will be recommended to NAVFAC as processes that can be added to existing building acquisition phases to achieve greater sustainability.

3.1. Research Goal

The primary goal for this research is to recommend appropriate and feasible sustainable development process improvements to a newly defined NAVFAC sustainable acquisition model.

This research will show that NAVFAC can adopt established and proven practices that are appropriately timed to realize a more sustainable facility.

3.2. Research Objectives

The intent of this research is to recommend a set of appropriate sustainable acquisition improvements to executive level leadership at NAVFAC. These improvements will consist of practices used by other government agencies that may improve the ability of the Navy to achieve sustainable policy goals. Once the improvements are identified, they will be presented to NAVFAC in an acquisition process framework that integrates with the existing Navy acquisition process.

To this end, the following four objectives were identified:

1. **Model Existing Acquisition Process:** Define project acquisition phases and sub-processes from initial project need assessment. Identify existing sustainable sub-

processes required by NAVFAC policy. Test model for accuracy by presenting to executive level management for feedback and revision.

2. **Identify Possible Improvements to Acquisition Process:** Collect sustainable development practices used by three government agencies with common sustainable development goals. Categorize and display these improvement candidates as they correspond to the NAVFAC acquisition phases.

3. **Validation through Navy Case Study Analysis:** Examine two recently awarded Navy construction projects and identify sustainable development processes used. Then compare those used by the Navy to the agency recommended improvements for analysis. If processes recommended by agencies were not used during the Navy acquisition process, and missed opportunities for greater sustainability occurred, then validation for new processes is supported.

4. **Generate NAVFAC Sustainable Acquisition Model (SAPM):** Combine current acquisition process framework with validated improvements to produce graphical aid for NAVFAC policy guidance and training.

3.3. Research Methodology

This section describes the research methodology used and steps taken to understand the environment being studied, acquire useful data, and effective tools to display the results. In addition to identifying this topic of research and conducting a literature review, four research methods were used in this study: (1) Organizational observation (2) model building process, (3) in-depth, unstructured interviews, and (4) process and outcome evaluation for two case study projects.

To understand this topic of research as it relates to the Navy, direct observation and participation in sustainable process planning and policy was conducted. Understanding the issues, constraints, and drivers for sustainable process improvements was made clear through committee experience with NAVFAC's Sustainable Working Group.

Models of sustainable development for government agencies do not currently exist. The Sustainable Acquisition Process Model (SAPM) was developed to organize existing sustainable processes used during the various acquisition phases. It serves as the framework to show how various processes can be retimed or added to create an improved overall approach to sustainable development. Modeling NAVFAC's processes produced a previously unavailable tool to represent the typical acquisition process. A graphical model was chosen to quickly and clearly show the actions and associated timing relative to well-known project phases.

Current practice and sustainable processes used by other agencies were identified through a series of in-depth, unstructured interviews with General Services Administration (GSA), The Pentagon Renovation Program (PenRen), and The Governor's Green Government Council of Pennsylvania. These interviews were intentionally open ended with a guiding set of questions presented to each interviewee designed to ascertain processes used by these agencies in sustainably designed projects. Next, analysis of these results were categorized and placed into the sustainable acquisition process framework.

Then, unstructured interviews were conducted with industry experts to compare the results with expert opinion and experience. This task was performed to gather additional insight and validate possible process improvements. However, the industry experts were not presented with the improvements identified by the government agencies. Instead, they were interviewed using questions that elicited their expert opinion identifying sustainable development processes that should be used throughout the building process

for a facility. The correlation between expert opinion and agency-identified improvements was independent of one another. Additional expert opinions and recommendations were also garnered from this series of interviews. Some of these opinions resulted in the identification of new processes that were added to the IC list.

This research analysis identifies processes that Navy project should be utilizing to better achieve sustainable goals. This is further supported by selecting two Navy case study projects for outcome evaluation[1]. Specific aspects and elements of the projects are reviewed and structured interviews with key project team members are conducted. The same process information is obtained for two different projects. The goal of these case studies is to corroborate the presence or absence of the proposed process improvement candidates with respective benefits or negative effects on the projects outcome. Project outcome is measured by LEED points obtained at 100% design completion.

3.4. Research Steps

These research methods presented above will be used to perform these five distinct tasks: (1) understand and model the NAVFAC acquisition environment and become familiar with existing policy, practice and direction, (2) identify possible process improvements, (3) assess improvement candidates for feasibility through expert concurrence, (4) validate improvements by case study analysis and, (5) construct revised NAVFAC SAPM.

3.4.1. Understanding the NAVFAC Sustainable Acquisition Environment

- **Understand executive level efforts to improve sustainable development:** Contact Lead Architect and Chairman for NAVFAC's Sustainable Working Group. Collect and review all written history of

[1] Outcome evaluation provides data on the extent to which the program met its intended objectives. [Jarvis, J. (2000). "Adequacy of Qualitative Research." John Jarvis, Ph.D.

efforts in the form of policy, in-house summaries and articles, and presentation notes from former NAVFAC leaders.

- **Become a participating member of NAVFAC's Sustainable Working Group:** Attend (2) two-day workshops to discuss present policy, current field and regional issues, and formulate solutions to emerging problems. Also participate in task group to identify acquisition strategies. Use executive level members as audience for feedback on possible research required for advancement of sustainable development policy and guidance. Review and provide comment on latest draft policy statement scheduled for issue February 2003.

- **Understand and construct NAVFAC acquisition model:** Create task group within Working Group to identify common acquisition processes associated with MILCON projects. Use working group to validate graphical model depicting basic project phases and sustainable policy currently in place.

3.4.2. Identify Possible Improvement Candidates

- **Select government agencies for process evaluation:** Review other government organizations and identify practices that contributed to the outcome of a sustainably designed project. Specifically, interview key leadership in these agencies that were responsible for sustainable development implementation in their respective agencies.

- **Analyze Raw Data from Interviews**: Examine data from these interviews as required from recorded media. Processes, actions or other considerations that experts voiced as being important or critical to the green building process will be listed. Categorize these processes into

groups of possible improvement candidates corresponding to the NAVFAC ACQ phases – similar to the data analysis performed on Agency provided data

3.4.3. Assess Proposed Improvements for SAPM

- **Assess Feasibility SAPM with NAVFAC Leadership**: Present improvement candidates to NAVFAC executive leadership for feedback on feasibility and constraint criteria to be used for final selection of process improvements.

- **Identify Sustainable Development and Design Experts:** Identify those leaders on the topic of sustainable development by literature review and personal conference attendance. Further consideration will be given to those experts with federal or government experience.

- **Interview Experts:** To validate initial improvement candidates from government agencies and to add additional insight, experts will be interviewed. The experts will not to be given a list of ICs previously identified, but rather, be asked to identify the critical processes needed to achieve sustainable development goals for a project. Note: The objective here is to achieve independent assessment of previously identified improvements.

3.4.4. Validate Proposed Improvements through Case Study Analysis

- **Identify appropriate case study projects:** Identify two recent, design-build, Navy MILCON projects with specific criteria set to minimize the chance of selecting a "show case" project. The intended goal is examine current standard practice on a Navy facility contract.

- **Conduct Analysis of Case Study Projects:** Interview Navy project managers and contracted designers to ascertain potential impacts (negative or positive) or design constraints imposed by the Request for Proposal (RFP). Specifically evaluate the processes improvements that were proposed by agencies and supported by experts.

3.4.5. Construct Revised Sustainable Acquisition Model

- **Select a Set of Processes for Recommendation:** Establish criteria to make final selection among improvement candidates. Importantly, this criteria will focus on the planning and programming phases.

- **Create Revised SAPM:** Integrate recommendations into existing NAVFAC SAPM to be presented to NAVFAC for policy guidance.

3.5. Summary

The four research objectives required five research steps to complete, understand the environment, identify improvements, assess improvements, validate improvements, and construct revised SAPM. The next chapter will discuss the construction of the original NAVFAC Sustainable Acquisition Model.

CHAPTER FOUR: DEVELOPMENT OF THE NAVFAC SUSTAINABLE ACQUISITION PROCESS MODEL (SAPM)

To understand the environment affected by efforts in achieving sustainable goals, the actions and milestones in the acquisition of a facility must be understood. The sequence of processes and the identification of the responsible parties were required to characterize the complete process and to develop a graphical representation of the NAVFAC acquisition process. Since this research is focused on the sustainable processes that maybe required from phase to phase, only the framework and processes directly related to achieving sustainable goals were developed. The resulting model is called the Sustainable Acquisition Process Model (SAPM).

4.1. Understanding the NAVFAC Acquisition Environment and Process

The NAVFAC acquisition environment is complex in that many contract delivery methods are used for a wide variety of services and facilities. The Navy acquires everything from typical office buildings to complex, highly technical, special purpose facilities. While some projects maybe successfully contracted with primarily performance-based specifications, other projects may require very prescriptive, military specifications (MILSPEC) to satisfy form and functional requirements. The SAPM will be aimed to depict the most often used project delivery system for typical facilities – facilities that do not require extensive MILSPEC guidance to satisfy strict requirements that may preclude full consideration of sustainable concept application.

This environment was examined explicitly by three methods, (1) Speaking and meeting with Construction Business Line Managers from the various NAVFAC regions, (2) Attending the sustainable working group meetings, and (3) from 6 years of personal experience working for Naval Facilities Engineering Command. Input from these sources provided the information needed to construct the SAPM.

4.2. Understanding the Existing NAVFAC Sustainable Policy and Practice

Within NAVFAC, processes occurring in the field tend to lag behind the policy that governs. The time requirements for implementation can sometimes be significant. In 1997, NAVFAC policy shifted to require the use of the design-build delivery method unless a field activity could support rationale for another delivery method. Design-build became the default method almost 6 years ago. In 2002, about 70% of all Navy construction projects were delivered by design-build. The lag between corporate policy and field level actions are most likely caused by the sheer size or the organization, geographic dispersion, local cultural and business influences, and normal resistance to change.

The method used to understand NAVFAC's current sustainable acquisition process was policy examination only. To model sustainable processes after actions being used in the various NAVFAC regions would have been very difficult due to the organization size alone. An assumption is made, that eventually, the policy promulgated by NAVFAC will become practice in all regions in the relatively near future.

4.3. Model Construction

The model construction format used was chosen for two reasons, to quickly show key processes and actions related to major acquisition phases and to benefit the researcher and NAVFAC personnel with a graphical process reference tool. The two-phase design-build acquisition process model was selected as the framework for sustainable process application. This project delivery type requires a two-step design phase where the architect used for preconstruction services and possibly concept design can not be contracted as the architect responsible for the design-build activity upon contract award (FAR 2002).

After determining the ten major acquisition phases for any two-phase design-build project, the initial phases were examined for further process breakdown. The planning and programming phases were expanded into six sub-phases. These sub-phases were identified according to level of approval required as a project progresses through the planning and programming phases. These six sub-phases were divided into sixteen steps that occur for every MILCON project subjected to the congressional appropriation process.

The following series of figures are described in more detail:

- Figure 4-1 The ten major acquisition phases and current sustainable acquisition processes required by NAVFAC Instruction 9830.1 and the expanded 6 sub-phases and associated sub-processes.
- Figure 4-2 The Planning through A/E Selection Phase. This A/E Selection Phase refers to the preconstruction services contracted by NAVFAC to aid in contract formation, concept design and RFP development.
- Figure 4-3 The Concept through Award Phase includes a functional analysis concept development charrette to ensure function and client requirements are sufficiently included in design. The first phase design-build architect drafts Request for Proposal documents and prepares concept drawings for bid packages or negotiations. Bidders are pre-qualified and briefed on best value selection criteria.
- Figure 4-4 The Construction through Turnover to Client include final design, construction and commissioning by the design-build contractor. The last step of client turnover and occupant move-in completes the acquisition process. For a period of at least one year after substantial completion, the NAVFAC contracting office and the design-build contractor address warranty issues.

- Figure 4-5 When the Planning and Programming Phase is expanded to include the DD 1391 approval process, 6 distinct phases emerge. The DD 1391 is the document that is submitted to Congress for budget approval for an individual project. The Activity Level Development Phase involves client and local NAVFAC project team members.
- Figure 4-6 The Installation Management Claimant Refinement is the sub-phase where project is compared with other local projects and project scope definition effort is continued.
- Figure 4-7 The Engineering Field Division Final DD 1391 sub-phase depicts the processes occurring at the regional level, as well as, the NAVFAC HQ review.
- Figure 4-8 The Final Budget (DD 1391) for the project is established and submitted to Congress for approval. Also, Acquisition strategy efforts, and first phase design (of two-phase design-build) commences.

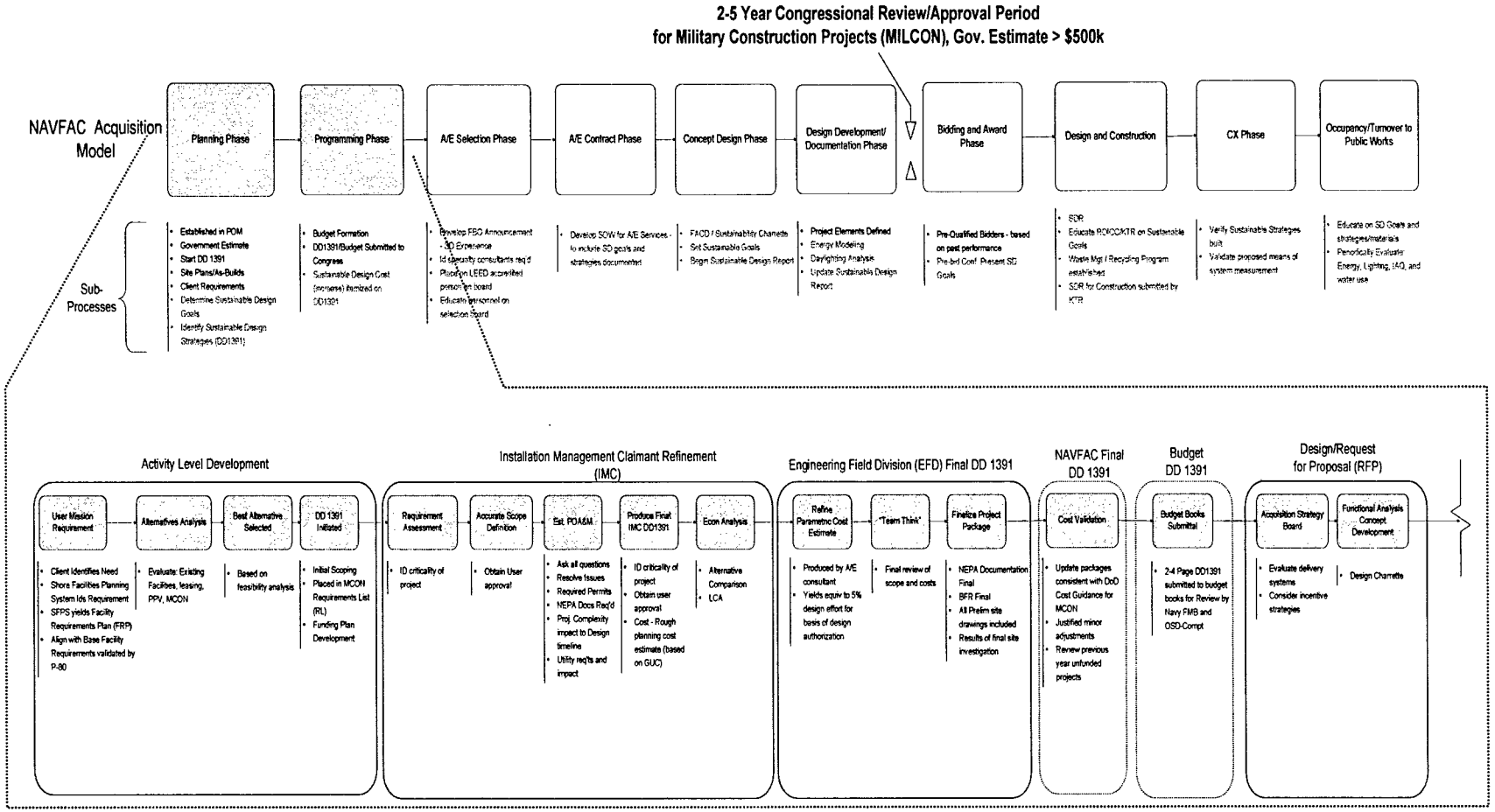

Figure 4-1. NAVFAC Sustainable Acquisition Process Model

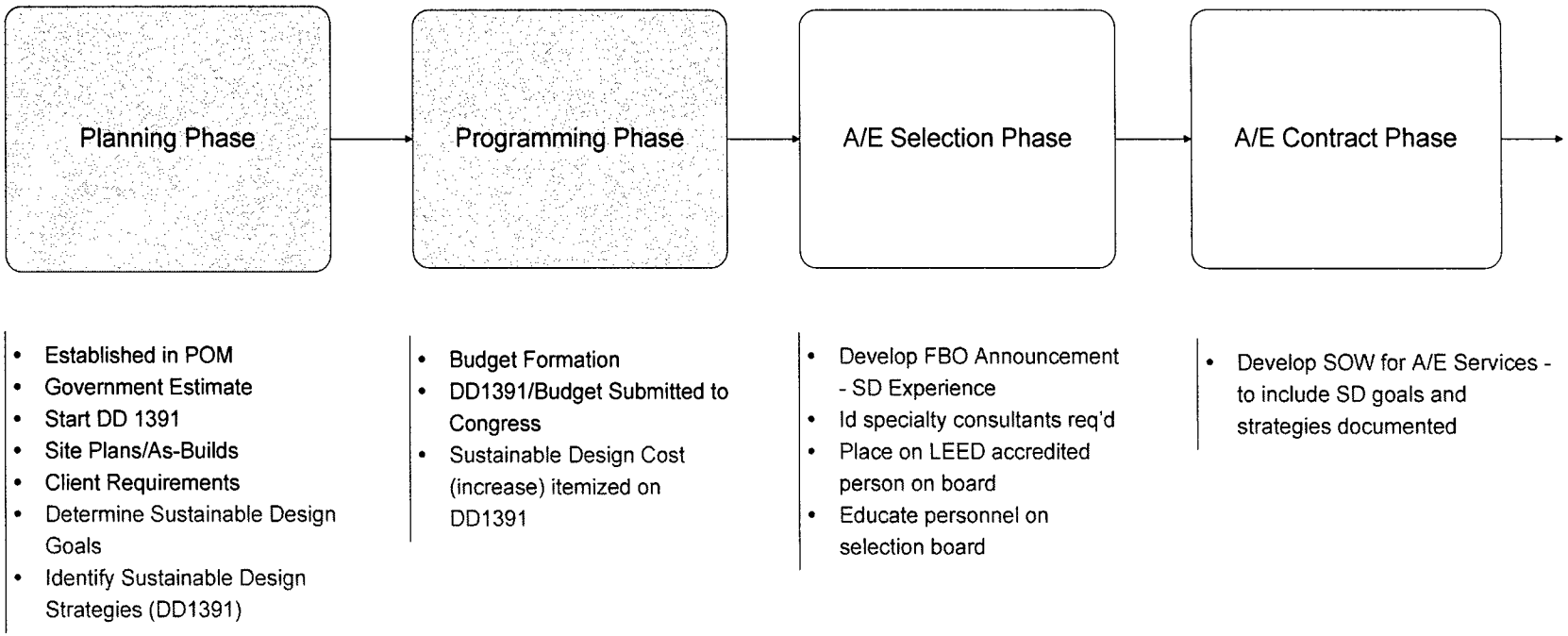

Figure 4-2. Planning through A/E Contract Phase

2-5 Year Congressional Review/Approval Period for Military Construction Projects (MILCON), Gov. Estimate > $500k

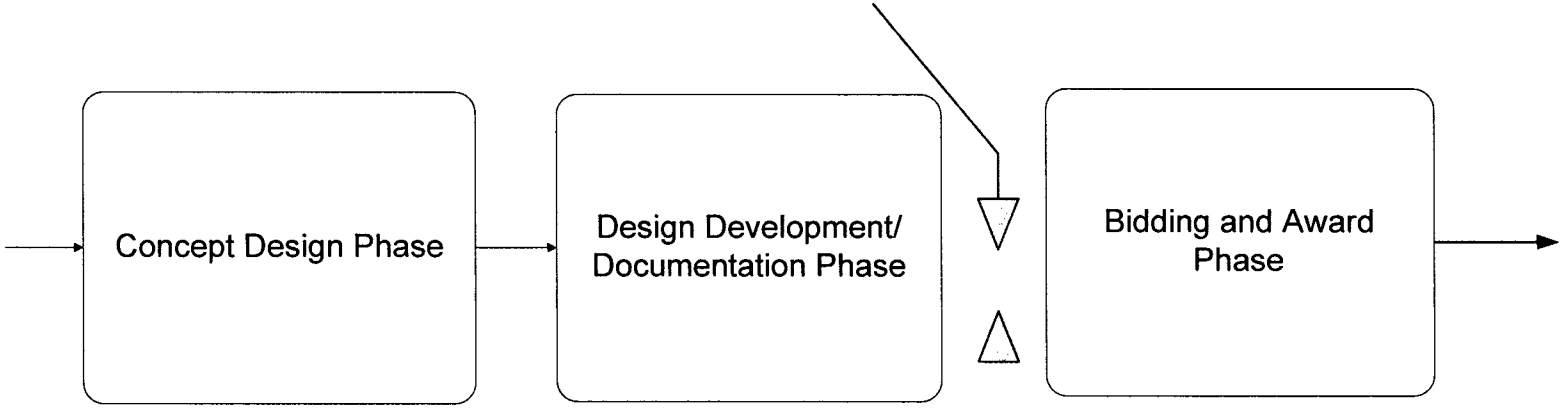

Figure 4-3. Concept through Award Phase

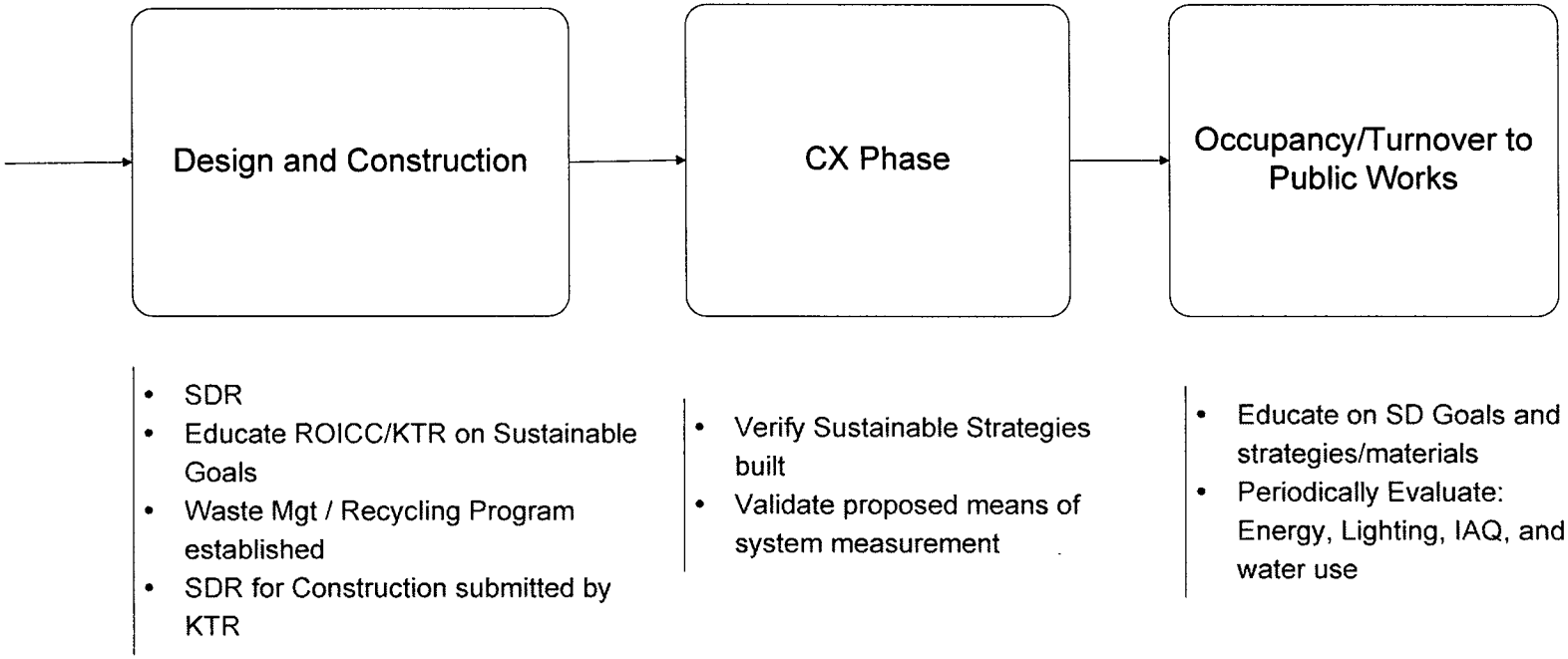

Figure 4-4. Construction through Turnover to Client

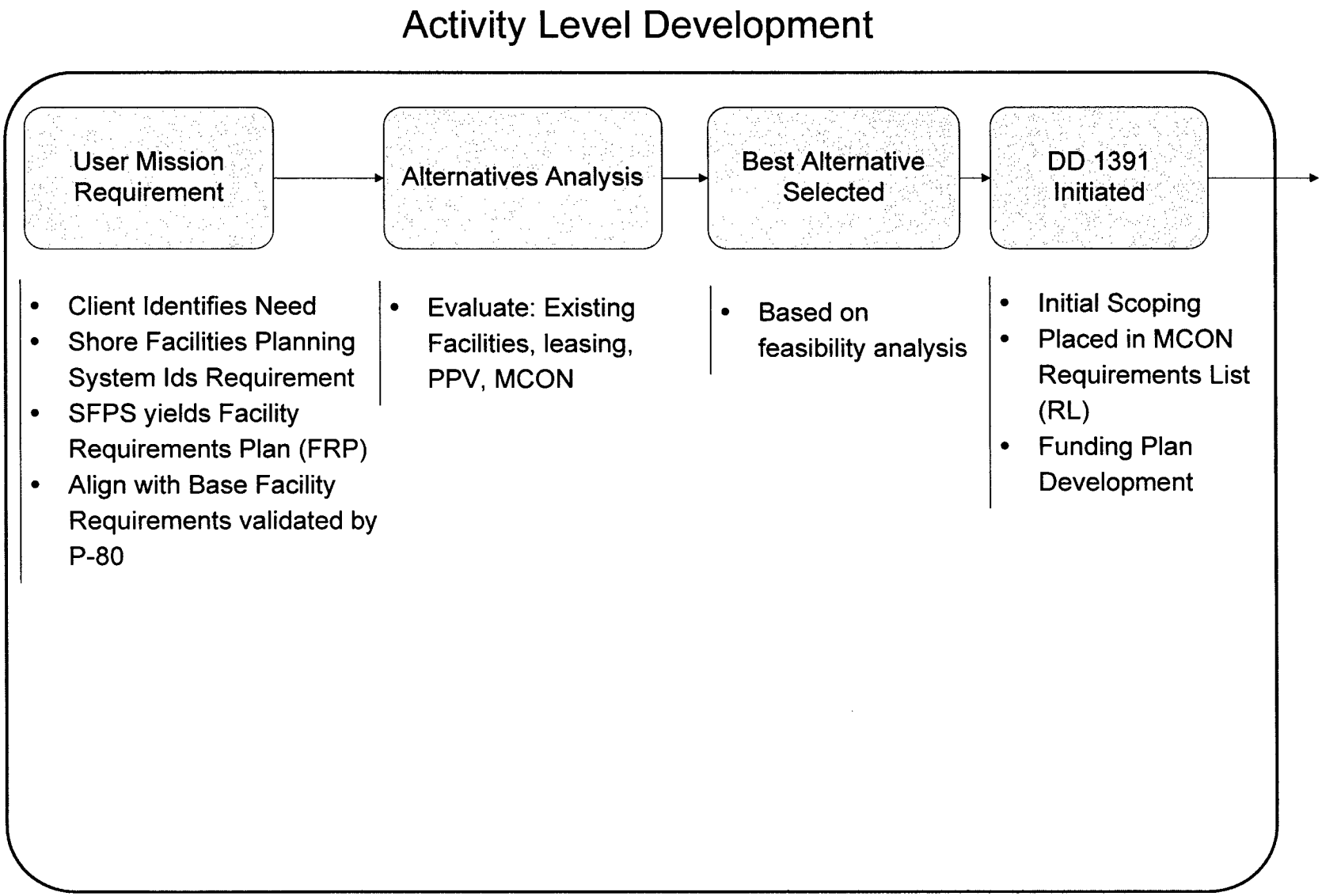

Figure 4-5. Activity Level Development

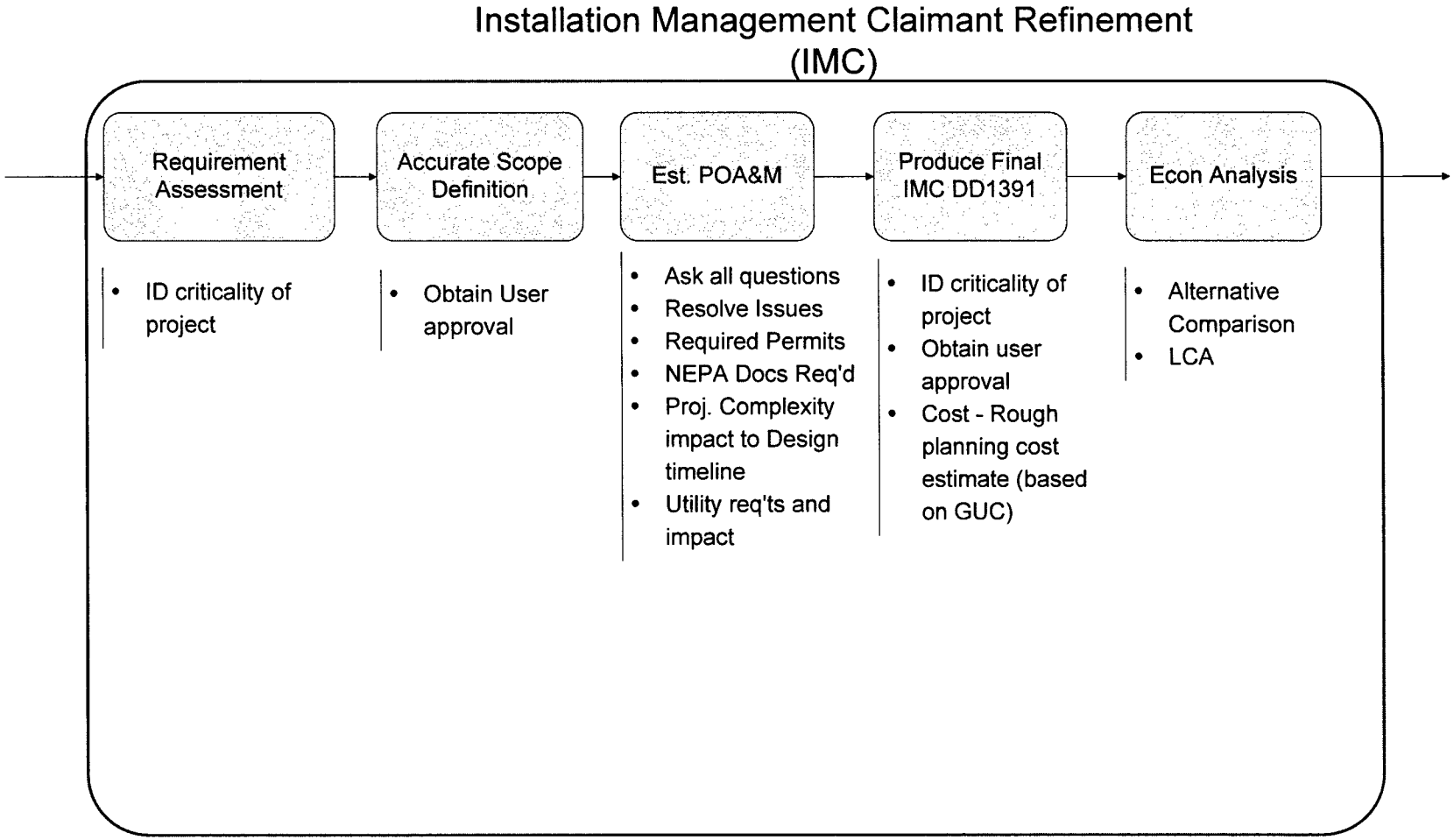

Figure 4-6. Installation Management Claimant Refinement

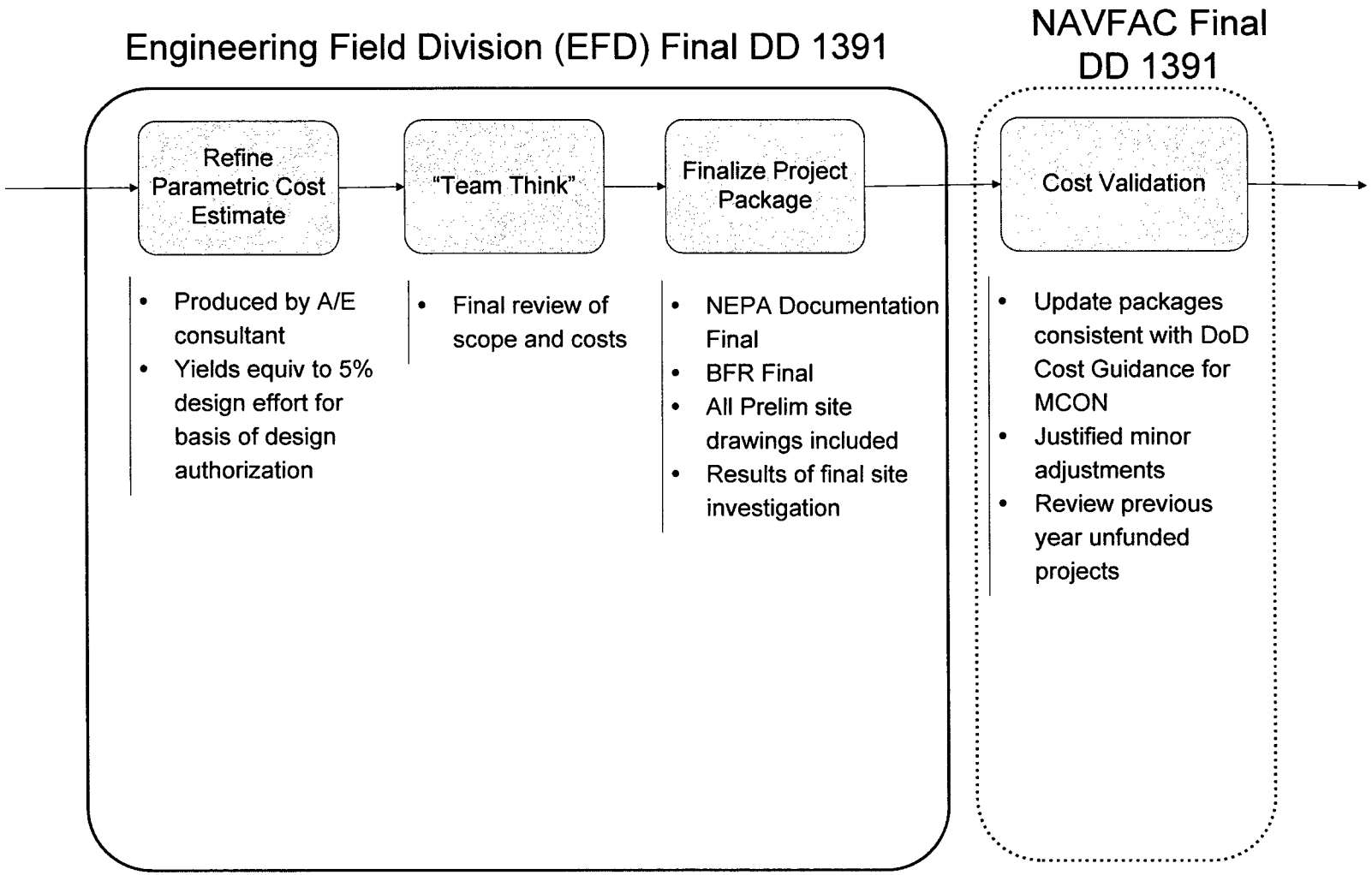

Figure 0-7. Engineering Field Division - DD 1391

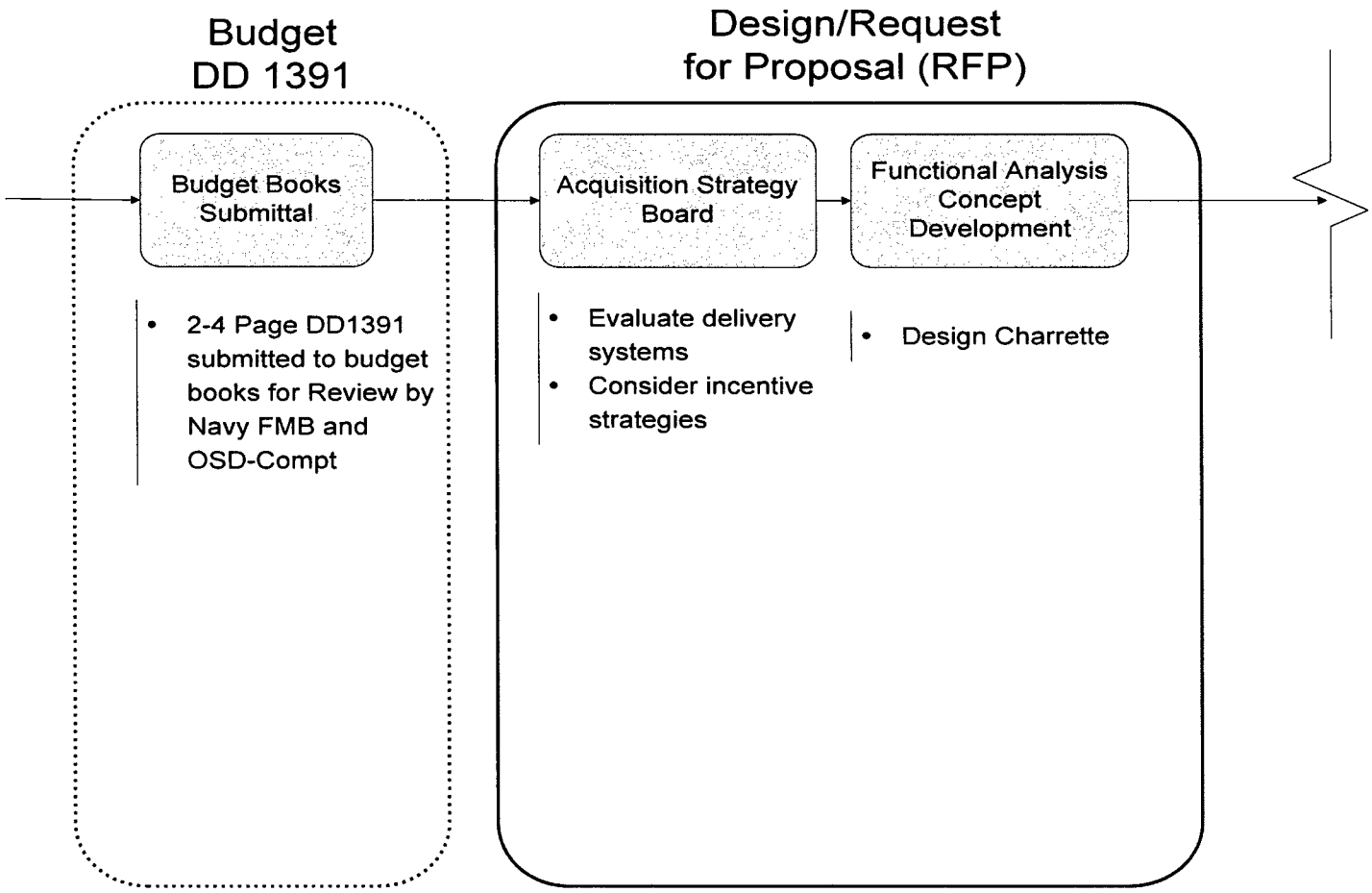

Figure 4-8. Budget Submission and RFP Development

4.4. NAVFAC Leadership Feedback for Model

The model provides framework for identifying existing NAVFAC processes and will be used to show new processes and the timing of those new processes - it is important that accurate reflection is achieved. This model was presented to NAVFAC's sustainable working group, as well as to other Construction Business Line managers from several regions of NAVFAC for review and feedback. This feedback was used to modify and correct mistakes in the original model construction. The model, as depicted in Figures 4-1 thru 4-7, represents NAVFAC's two-phase, design-build acquisition process resulting directly from this research.

4.5. Summary

This chapter is dedicated to setting the boundaries for the domain to be studied. The NAVFAC design-build acquisition process was studied and documented in the form of a graphical model. This model identifies processes and details sequential relationships between acquisition phases, sub-phases, and processes from the planning to building occupancy.

CHAPTER FIVE: IDENTIFICATION OF PROPOSED IMPROVEMENTS

The intent of this research is to evaluate actions and processes to assist NAVFAC in achieving policy mandates. One obvious method to seek improvements would be to evaluate similar organizations and document their experience in achieving similar goals. While other organizations will operate and may achieve their goals, they do so under, inherently, different conditions and constraints than does NAVFAC. This may make comparison difficult, unless however, the organizations operate under similar constraints. These similarities may include budgeting processes, appropriation timelines and schedules that are managed by employees with a common link to the employees working at NAVFAC. This has led to the selection of three government agencies.

In general, government agencies were chosen as the source for sustainable process improvements. The five main supporting factors or assumptions for this decision are: (1) all have similar acquisition regulations, (2) all are non-profit, (3) all work under similar ethic requirements, (4) employees have similar pay schedules, (5) all have similar bureaucratic systems in place, and (6) all agencies were accessible by the researcher

5.1. Criteria for Selection of Improvement Sources

Since government agencies were identified as the general source for improvement candidate identification, the criteria for source selection within the government sector requires further definition. In general, any government agency that acquires new or renovated facilities would qualify as a source. However, criteria were established to efficiently choose agencies that may provide the most applicable improvement candidates. In addition the following rules for selection, pragmatic considerations limited the source selection to only three other comparable building organizations.

The criteria used to select comparable agencies are as follows:

- **Large government agency:** Since NAVFAC is a large government agency that is constrained by federal regulations and multiple levels of bureaucracy, organizations dealing with similar factors were used.

- **An organization using design-build acquisition strategies:** NAVFAC is utilizing design-build as the primary project delivery method for new or renovated facilities. Selecting organizations that use similar project delivery systems may present similar environment for comparison.

- **Pursuing LEED certification in current construction projects:** This criterion will align goals of comparable organization with NAVFAC's policy guidance that requires a project to be designed to meet LEED certification requirements.

- **An organization advocating sustainable design:** Advocates for sustainable design maybe implementing the new processes and taking advantages of industry resources not yet mainstreamed by other agencies.

- **Access to information and appropriate contacts must be feasible:** The ability to quickly liaison and make contact with appropriate personnel in potential organizations was critical. Additionally, the level of confidence in securing data and interviews with selected organizations needed to be high. Finally, relatively close proximity of sources was required to minimize travel and research costs related to required organization interface.

5.2. Improvement Source Descriptions

Based on the criteria for improvement source selection, the following government agencies were used as sources for improvement candidates: (1) Pennsylvania's Green Government Council, (2) The Pentagon Renovation Team, (3) General Services Administration. Personnel who were leaders or champions for sustainable development, management and policy implementation for the respective organization were contacted as

the liaison to collect research data. The personnel were comprised of various levels of authority from national sustainable design coordinator, to regional project executives, local project managers, asset managers, and integrated project team leaders.

5.2.1. Pennsylvania's Green Government Council (GGGC)

The Governor's Green Government Council (GGGC) was created in 1998 to help the state government adopt environmentally friendly operation policies and practices. The council works cooperatively across agency jurisdictions, putting sustainable practices into state government's planning, policymaking, and regulatory operations and striving for continuous improvement in environmental performance. Agencies will focus on planning and operations, particularly energy efficiency in areas such as building design and management, procurement of environmentally friendly commodities and services, vehicle purchasing and recycling. The GGGC is jointly chaired by the secretaries of the departments of Environmental Protection and General Services.

Former Governor Tom Ridge signed an Executive Order (1998-1) on March 25, 1998, creating the Governor's Green Government Council. Its purpose is to help Pennsylvania state government integrate "environment-friendly" principles into its policies and practices. The Council itself, comprised of agency heads or their designees provides overall oversight for the initiative and serves as a forum for addressing interagency issues (GGGC 2002).

The interviewee selected, Jim Toothaker, represented GGGC for this research and was the former Director of the Bureau of Office Systems and Services for the Department of Environmental Protection (DEP) of Pennsylvania. Mr. Toothaker served as project manager for Pennsylvania's first 'green building' and as sustainable development champion for DEP until retirement in 2001. Before retiring, he made progressive steps to implement new solicitation and source selection techniques that would help DEP achieve sustainable development goals. The interview summary sheet is found in Appendix B.

5.2.2. Pentagon Renovation Team (PenRen)

The Pentagon Renovation Program was established in 1991 to undertake the first renovation of the 6.5 million square foot building since its construction in 1941. The scope of the renovation project included slab-to-slab demolition, abatement of hazardous material and reconstruction to comply with modern building codes and fire and life safety codes. Today, the PenRen Team manages $4+ billion in new and renovation work in and around the Pentagon.

In 2001, Dr. Teresa Pohlman created the Sustainable Design Team as a single source of guidance and information for all PenRen projects (Pulaski 2003). Since then, she has led efforts to achieve LEED certification for various PenRen projects and achieve LEED certification goals for this large Department of Defense construction program and was chosen as the Integrated Project Team Leader for constructability and sustainability.

5.2.3. General Services Administration (GSA)

The mission of GSA's Public Buildings Service is to provide a superior workplace for the federal worker while using taxpayer dollars to the fullest. With a vision to best real estate organization in the world, GSA has become a leader in sustainable development efforts. With a total inventory of over 330 million square feet of workspace for a million federal employees in 2,000 American communities, GSA has established a robust management system to implement sustainable design concepts into all new and renovated facilities. This comprises over 1,700 government-owned buildings and privately owned leased facilities.

Through their Design and Construction Excellence programs, GSA has implemented sustainable acquisition processes in an attempt to balance cost, environmental, societal and human benefits while meeting the mission and function of the intended facility centers. GSA has produced several documents that give guidance to A/Es and contractors in the pursuit of meeting sustainable goals for all projects. GSA now uses the

LEED rating system as a goal in design criteria for A/E services as well. Beginning in FY 2003 all new GSA building projects must meet criteria for basic LEED™ certification.

The interviewee representing GSA was the Director of Sustainable Design Program, Mr. Don Horn, AIA in the Washington D.C. headquarters office. In addition to managing GSA sustainable development policy and providing guidance, he also coordinates the regional sustainable development champions in their pursuit of achieving local sustainable development objectives.

5.3. Method for Improvement Identification

To identify the improvement candidates to be carried forward for further validation and possible application to the NAVFAC SAPM, a simple two-step method was implemented. First, general criteria were established to filter any identified processes that would be precluded from implementation based on Navy regulations or that lies outside of the NAVFAC acquisition process. Then, recommended processes from all three agencies that passed the selection criteria were recorded.

5.3.1. Criteria for Improvement Candidate Selection

All processes used by other agencies expressed to have served a significant role in achieving sustainable development goals should be given initial consideration for application to the NAVFAC model. Some of these processes may be similar to those currently used by NAVFAC; yet others may not be feasible for NAVFAC due to unique constraints. However, to aid in identifying all possible and applicable processes used by other agencies, three simple guidelines were established:

- Process used must be applicable to the ten NAVFAC acquisition phases or to the acquisition process in general.
- Must be able to apply process with violating Federal Acquisition Regulation (FAR).

- The process must be identified by that agency as a process or action that assisted in achieving sustainable goals for a particular project.

5.3.2. Improvement Candidates Selected for Validation

A total of 40 ICs were identified for all acquisition phases. The acquisition timing for 35% of these ICs is located in the planning and programming phases. Eight of the forty ICs were identified unanimously by all three agencies as actions or processes that were used during their respective facility acquisition process. The ICs identified for all acquisitions phases and are presented using Table 5-1. The entire chart with all results can be found in Appendix F. Figure 5-1 below explains the table and data documented within.

Improvement Candidates (IC)	IC #	Current NAVFAC Practice	Government Agency			Improvement Candidate	Industry Experts			Case Studies		Improvement Recommendations	
		Per Policy Guidance	GGGC	Pen Ren	GSA	(Yes/No)	RMI	ENSAR Group	Natural Logic	P-036	P-101	New Processes	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
ACQ Phase													
Improvement Candidates	#	X	X	X	X	Y/N	X	X	X	Y/N	Y/N	Y/N	Move

Figure 5-1. Example of Improvement Candidate Table

Figure 5-1 represents data collected at all phases of this research. In this chapter and subsequent chapters, this table will be used to illustrate results and demonstrate analysis techniques. In future tables, not all rows and columns will be required for illustration and may be hidden for clarity. The complete table may be found in Appendix F. Provided below are descriptions of the column data:

- Column (1) lists the Improvement Candidates (IC) identified by government agencies.
- Column (2) gives the IC unique reference identification.
- Column (3) identifies whether or not the IC was already a required process per NAVFAC sustainable policy.
- Columns (4-6) denote whether or not GGGC, PenRen, or GSA used this IC in their acquisition process.
- Column (7) is checked if the IC passed established criteria and was then carried forward for expert assessment and case study application.
- Columns (8-10) denote whether or not RMI, ENSAR, or Natural Logic recommended this IC be included in the Navy's acquisition process.
- Columns (11-12) denote whether or not the two Navy cases studied used this IC in their acquisition process – specifically the planning and programming phases.
- Column (13) marks if this IC is to be recommended to NAVFAC for implementation.
- Column (14) marks if this IC already existed per NAVFAC Policy and requires shift in timing. This shift would be related to the timing the agency used for this IC.

In Table 5-1, all improvement candidates are represented for the Planning and Programming phases only. For these two initial acquisition phases, 17 candidates were identified by the three agencies – two already existed per NAVFAC policy and were added to list. However, during the interview and data collection process, all phases of acquisition for the three agencies' were discussed and documented. This was completed

to gather all potential improvements since other agencies' acquisition phases were not identical in function or timing to that of the NAVFAC's.

Five of the seventeen improvement candidates for the planning and programming phases also received a unanimous identification as processes used in the agencies' planning and programming phases:

- Assign Sustainable Design Champion
- Conduct Goal Setting Charrette
- Use Energy and Day-lighting Modeling during Siting
- Determine Sustainable Goals
- Use Sustainable Design Consultants

Table 5-1 Improvement Candidate Identification Matrix

Improvement Candidates (IC) Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	**Current NAVFAC Practice**	**Government Agency**			**Improvement Candidate?**
		Per Policy Guidance	GGGC	PenRen	GSA	(Yes/No)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Planning Phase						
Ensure Project Manager has had LEED Training (accreditation not required)	1		X			Y
Assign (1) LEED accredited member (in-house) to planning team	2				X	Y
Assign Sustainable Design Champion	3		X	X	X	Y
Provide Timely Sustainable Design Training for Project Managers - project specific	4				X	Y
Conduct Goal Setting Charrette	5		X	X	X	Y
Educate Owner and Occupants on Sustainable Concepts and Impact	6		X		X	Y
Involve Cx Agent in first Charrette	7				X	Y
Provide Sustainable Concepts Orientation to Key Leaders (Owners)	8				X	Y
Use Sustainable Design Consultants	9		X	X	X	Y
Determine Sustainable Goals	10	X	X	X	X	Y
Prioritize Sustainable Goals	11		X			Y
Ascertain Building Owner (President or Commander) Explicit Buy-in	12		X	X		Y
Develop Performance Standards in Initial Charrette	13		X			Y
Use Energy and Day-lighting Modeling during Siting	14		X	X	X	Y
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	15			X	X	Y
Identify Sustainable Design Strategies	16	X				Y
Programming Phase						
Include sustainable design elements in initial Government Estimate	17				X	Y
Allow 5-7% Project Growth for Sustainable Design	18				X	N
Itemize Additional Sustainable Design Costs on DD1391 Form	19	X				Y

Three of the improvement candidates (IC), were considered for further validation and possible application to NAVFAC's acquisition (ACQ) process, however, these processes maybe difficult to implement based on current practice and funding constraints. ICs # 9, 17 and 18 are the three in question.

IC #9 requires the use of sustainable design consultants during the planning phase for a project. This may pose a challenge for local project managers in that funds available for pre-design services are limited to feasibility studies and environmental assessments. Typically, no architectural and engineering (A/E) services for the proposed facility are tendered in this phase of acquisition. This IC was considered because there is no regulation restricting this consideration, however, regional construction business line managers (BLM) will need to address this expense in future budget requirements.

IC #17 requires sustainable design elements to be included in initial government estimate. Again, this will pose a timing problem since initial government estimates are completed based on historical building data, estimated square foot facility requirements and contingency allotment. The implementation of this IC relies on considerable effort in the planning phase that set SD goals and use other than historical data for square foot cost estimating.

IC #18 considers the flat rate addition of 5-7% project cost growth to achieve a sustainable design. This IC was recommended by GSA and is an approximate value based on recent GSA project data from LEED rated facilities. This IC, however, has no supporting data available at the time of this research to substantiate such a claim and will not be considered for application to NAVFAC's SAPM. This is, however, an important claim by GSA. This represents a general effort to invest more initially to take advantage of life-cycle return on investment.

ICs # 10, 16 and 19 were already processes required by NAVFAC policy. These ICs were included to show where other agencies had concurrence, or possibly, where other

agencies may have a different timing for same processes – which may suggest retiming a current NAVFAC processes. IC #10 was in concurrence with all three other agencies while 16 and 19 were not used by any of the agencies' ACQ processes. IC #16 was not specifically identified in any of the agencies processes, but is most likely completed during design charrettes in the design development phase for the other agencies. IC #19 is not used by the other agencies due to differing budget documents and approval processes by higher authority.

Most of the ICs listed could be implemented by two levels of NAVFAC management. The construction BLM for the various regions is responsible for ensuring that project managers are taking the necessary steps to initiate projects, while the local project managers are responsible for the specific processes that are used to carry the project forward. With the exception of funding for sustainable design consultants, the local project managers are able to either delegate or complete themselves, the ICs listed in Table 5-1.

5.4. Summary

This chapter presents process improvement candidates identified by three government agencies. Existing sustainable ACQ processes were also included for comparison and possible retiming based on agency improvements and expert opinions. A total of 53 ICs for all phases were identified by the agencies. Seventeen or 32% of these were implemented in the planning and programming phases. In the next chapter, results from expert interviews are added to the analysis for final selection of sustainable acquisition process improvements.

CHAPTER SIX: IMPROVEMENT ASSESSMENT, CORROBORATION AND VALIDATION

Once improvement candidates were identified by the government agencies and then reviewed for application the Navy's acquisition process, initial results were subjected to series of steps to assess, corroborate, and then finally validate for potential application through the evaluation of two case study projects.

The primary consideration given in the selection of ICs was dependent on the ability for these improvements to effectively be incorporated into the existing NAVFAC process without major reorganizations or disruption to existing processes. To achieve this primary consideration, the initial IC's were presented to the NAVFAC Sustainable Development Working group for feedback.

Upon initial assessment from NAVFAC, experts in a variety of AEC and research organizations were interviewed for corroboration of agency identified improvement candidates. During this step of assessment, the experts also reviewed the NAVFAC acquisition process model to gain an understanding for the research effort underway.

Finally, to evaluate the ICs for appropriateness in both timing and function, two case studies were performed. NAVFAC project managers and project designers were interviewed and provided data for this evaluation.

6.1. Assessment by NAVFAC Leadership

Primary consideration for IC application depended on timely feedback from NAVFAC executives. The appropriate forum for this feedback was provided by the Sustainable Working Group meeting in early February 2003. Here, the ICs proposed in Table 5-1 were presented and discussed. Members of the working group present included lead architect for NAVFAC, five Business Construction Line Managers, two regional sustainable development champions and several personnel from the Navy's energy program.

While no direct objections were given to the improvement candidates, there were several key negative concerns resulting from the discussions:

- The creation of new positions to accomplish ICs
- Funding source used for new or retimed processes
- Scale of education requirements for key leaders and project managers

While the addition of new job positions to implement sustainable development policy is not impossible, it is however, unlikely that this would occur immediately and thus, any ICs would have to be conducted with resources already in-house or by regionally contracted services. Personnel availability could pose a significant constraint on capability to implement all ICs recommended.

Concern was expressed over the source of funds ("colors of money") that would be required to legally pay for additional services or for services conducted at different acquisition phases. Again, these unknowns would require further analysis and decision by regional and headquarters' comptrollers.

Several of the ICs indicated the need for LEED rating certification for project managers. To complete this on a large scale would be, initially, cost prohibitive based on current education budgets. This type of training maybe be more feasible if presented by an online training system or if conducted by an in-house training team.

6.2. Improvement Corroboration by Industry Leaders

With the improvement candidates passing an initial screening by the Sustainable Working Group for feasibility, data from industry experts was sought for validation and additional insight and possible additions of improvement candidates based on the latest sustainable development technologies and strategies. The selection of these experts was based on criteria aimed to address the top US leaders on this subject.

One important consideration made at this point was to not show the experts the list of improvements identified by the government agencies, but rather to have the experts give their professional opinion and then match those to the ICs identified by the agencies.

6.2.1. Criteria for Expert Selection

Identifying several of the leaders in the area of sustainable development was primarily achieved during the literature review. The Navy also published a list of thesis topics for Naval Graduate student to consider. This list made reference to an organization that could be reviewed. In October of 2002, the US Green Building Council hosted the Smart Design Forum III for Green Building Practices in Washington D.C. Here industry leaders from across the country presented their perspectives on a variety of issues related to the advancement of sustainable development. By reviewing papers and listening to speakers from this conference and conducting a literature review, a clear list of leaders in sustainable development emerged.

While examining potential experts to be used for corroboration purposes, a broad spectrum of AEC industry sectors was reviewed. There appear to be several main categories of sustainable experts. There are leaders in environmental design and engineering services, sustainable development research, and sustainable development consultant services. To gain representation from each of these industry sectors, one organization from each was selected and a point of contact was contacted for an interview. The three organizations were, (1) Rocky Mountain Institute (RMI), (2) ENSAR Group, Inc, and (3) Natural Logic, Inc.

6.2.2. Expert Organization Descriptions

1. **Rocky Mountain Institute** is a non-profit organization that promotes the efficient and restorative use of natural, human and other natural capital. RMI conducts research to include whole system and integrative design and end-use/least-cost analysis. RMI also reviews and studies advanced technologies and techniques for commercial application. RMI works with business, civil

society, and government to design integrative solutions to help meet sustainable development objectives. Rocky Mountain Institute was established in 1982 by resource analysts L. Hunter Lovins and Amory B. Lovins (RMI 2002).

2. **ENSAR Group, Inc.** provides architectural services for residential and selective commercial projects and provides design consultation and analysis to other architects. ENSAR Group offers architectural design services for a range of building types including institutional facilities such as schools and laboratories, commercial spaces, master planning, and private residences. ENSAR maintains a focus on environmental analysis to develop sustainable architectural design solutions (Ensar 2003).

3. **Natural Logic, Inc.** provides services and technologies that are aimed to deliver strategic consulting, integrative design solutions, internet-based decision support software, management training, workshops, and related business services to help minimize waster and achieve sustainable goals (Natural Logic).

6.2.3. Interview Process

The interview process for industry experts was slightly more structured than the previous agency interviews, but still allowed for open discussion. While additional insight from these experts was welcome, the primary intent for the interview was to corroborate previously identified ICs. In addition, the NAVFAC acquisition model was presented as a framework build upon and facilitate the interviews. The format of questions asked led to discussion about processes and the timing of those processes to be applied to the NAVFAC acquisition framework.

6.2.4. Interview Results

The pertinent data compiled from these expert interviews is represented in similar format to the agency data. The exact relationships can be identified in Table 6-1 and the entire table showing all relationships can be viewed in Appendix F. A total of 29 ICs were identified by the experts for all acquisition phases. Of these 29 ICs, twenty corroborated with agency identified ICs – and 12 of these were located in the planning acquisition phase. The acquisition phase timing for 41% of the total 29 expert ICs is located in the planning phase.

Table 6-1 presents the expert opinions for RMI, ENSAR and Natural Logic. Columns 4-7 are hidden for simplicity. The table in its entirety is in Appendix F.

Table 6-1. Expert Interview Data Results

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	**Current NAVFAC Practice**	**Industry Experts**		
		Per Policy Guidance	Rocky Mountain Institute	ENSAR Group	Natural Logic
(1)	(2)	(3)	(8)	(9)	(10)
Planning Phase					
Ensure Project Manager has had LEED Training (accreditation not required)	1		X	X	X
Assign (1) LEED accredited member (in-house) to planning team	2				
Assign Sustainable Design Champion	3		X	X	X
Provide Timely Sustainable Design Training for Project Managers - project specific	4		X		
Conduct Goal Setting Charrette	5		X	X	X
Educate Owner and Occupants on Sustainable Concepts and Impact	6		X	X	
Involve Cx Agent in first Charrette	7		X		
Provide Sustainable Concepts Orientation to Key Leaders (Owners)	8			X	X
Use Sustainable Design Consultants	9		X	X	X
Determine Sustainable Goals	10	X	X	X	X
Prioritize Sustainable Goals	11				
Ascertain Building Owner (President or Commander) Explicit Buy-in	12		X		
Develop Performance Standards in Initial Charrette	13		X		
Use Energy and Day-lighting Modeling during Siting	14		X	X	X
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	15				
Identify Sustainable Design Strategies	16	X			
Programming Phase					
Include sustainable design elements in initial Government Estimate	17				
Allow 5-7% Project Growth for Sustainable Design	18				
Itemize Additional Sustainable Design Costs on DD1391 Form	19	X			

Six of the nineteen improvement candidates (1,3,5,9,10,14) for the planning and programming phases were identified by all three experts as actions or processes that should be used during the acquisition of a sustainable facility. These listed ICs only represent the strongest corroboration for agency identified ICs:

- Ensure Project Manager has had LEED Training (accreditation not required)
- Assign Sustainable Design Champion
- Conduct Goal Setting Charrette
- Use Sustainable Design Consultants
- Use Energy and Day-lighting Modeling during Siting

Of the planning and programming nineteen, five ICs (2,11,15,17,18) were not corroborated by the experts at all:

- Assign (1) LEED accredited member (in-house) to planning team
- Prioritize Sustainable Goals
- Allow 5-7% Project Growth for Sustainable Design
- Include sustainable design elements in initial Government Estimate
- Assign Independent Experts (In-house) for Sustainable Design / Peer Review

This does not necessarily mean that these processes are not ineffective , however, all five were weekly supported by the agencies - only one agency identified each of these ICs as a processes used. Concurrently, the experts did not explicitly and independently identify these actions as necessary to achieve a project's sustainable goals. Therefore, these ICs were not considered for application to the revised NAVFAC SAPM

6.2.5. Summary of Expert Opinions

All three experts interviewed agreed that the acquisition process model was essential to provide a framework for evaluating and timing processes in order to make good decisions at the most effective time. When presented with the initial NAVFAC

acquisition model, all agreed that it was an appropriate starting point for process analysis and, perhaps, more could be represented in the model. Some of the recommendations were to identify specific constraints such as regulations or time restrictions that are tied to the acquisition phases. Also recommended was the assignment of specific NAVFAC job descriptions linked to proposed sustainable processes. This would clearly identify the responsible persons for actions at each ACQ phase.

Another common thread of expert advice stressed the need for effective communication between all project stakeholders. Good communication practice within in specific processes is important, but is even more important as a project moves from one phase to another and new parties become involved. The project "hand-off" phenomena common to highly structured processes, especially in government ACQ systems, tend to be segmented and disrupt communication between parties. While no recommendations were given pertaining directly to sustainability, the general consensus among experts was that implementation of new processes would require more effective communication.

6.3. Validate Improvement Applicability by Case Study Analysis

With continued focus on the applicability of this research, case study analysis was conducted to evaluate immediate potential for integration of proposed improvements. Two projects, representative of more than 60% of all Navy MILCON projects, were selected to evaluate the effectiveness of the efforts applied in the planning and programming phases to achieve the Navy's sustainable goals.

To perform this analysis, a set of criteria was used to select construction projects that would provide data enabling project comparison, as well as, comparison with proposed sustainable acquisition process model. Then through the following steps, the case studies were conducted; (1) Obtain RFP and site layout plan (if not included in RFP), (2) Interview Navy Project Manager, and (3) Interview Architect of Record.

6.3.1. Criteria for Case Selection

Some projects in the Navy that receive notoriety usually do so by positive achievements in design and construction. During this research, when Navy projects were initially sought for case study purposes, the only projects identified relating to sustainability had achieved successful results. From previous NAVFAC working group discussions, it became apparent that not all projects planned to meet sustainable goals were actually doing so. So, to fairly address this issue by limiting publicity bias, two case study projects that have neither been identified as successful or as failures were used.

The following criteria were established to limit publicity bias and identify two case study projects for analysis:

- Navy Military Construction Project (MILCON)
- Design-build awarded within past year (January 2002-January 2003)
- New Structures (no renovation component)
- Supporting Case Study Material Available for Interview
- Navy Project Manager and Architect of Record Available for Interview
- 100% Design Complete
- Construction in Progress (as of April 2003), no final LEED score obtained
- No unusual publicity of projects presented to Navy or Other
- No personal (researcher) knowledge of project prior to selection

6.3.2. Case Descriptions

These two construction projects were unique and presented typical challenges for both the planners and designers. These were single contracts for new buildings awarded using the two-phase design-build delivery method. Tables 6-2 and 6-3 briefly describe the two case study projects.

Table 6-2.. Case Study #1: P-101

Project Title	P-101: Special Communications Requirement Integration Facility
Contract No.	N62477-02-C-0010
Location	Webster Field Annex: Saint Inigoes, Maryland
Award Price	$3.5 M
Description	Construction of administration facility with an equipment integration garage and employee parking and antennae/deployment testing field.
Facility Size	20,100 SQFT
LEED Score Required	26
LEED Score after Design	26

Table 6-3. Case Study #2: P-036

Project Title	P-036: Bachelor Enlisted Quarters (BEQ) B-1686
Contract No.	N62477-02-D-0040
Location	Naval Air Facility Andrews, Camp Springs, Maryland
Award Price	$ 8.2M
Description	Demolition and Construction of new 60 unit barracks facility, new utilities and resident parking
Facility Size	42,000 SQFT
LEED Score Required	26
LEED Score after Design	24

6.3.3. Case Study Method and Steps

To evaluate both case studies in a consistent manner, case study steps 1-3 previously listed were performed simultaneously for both projects. This was done to eliminate the influence of information from one project to alter the information ascertained from the second.

Only two projects were selected for pragmatic reasons. Time constraints for this research prevented additional case study consideration. Additionally, there was limited availability of projects passing the project selection criteria established.

Three elements unique to these case study projects were evaluated or considered for data collection. The request for proposal (RFP) was used to examine sustainable requirements established for the project. This document was also used to help ascertain the processes that may have been completed in the planning and programming phases. This document would also serve as common link when interviewing the Navy project manager and the design-build architect.

Next, interviews were conducted with the Navy project manager (PM) to identify processes and actions taken to satisfy sustainable policy for the specific projects studied. Here, a set of *Yes/No* questions were asked to the PMs for both projects. This list of questions was used as a guide during the personal interview. In Table 6-4, the results of the Navy PM interviews are displayed.

After conducting the project manager interviews for both projects, the architects were given a list a *Yes/No* questions with a conditional follow-up question. The answer to this follow-up question was intended to elicit further professional opinion related to design advantages or constraints created by the *Yes/No* answer. These conditional questions were also the mechanism to allow the ICs to be validated by these case studies. Additional comments were also allowed for further amplification. In Table 6-5, the architects' results are displayed.

6.3.4. Request for Proposal

The RFPs for both projects were examined for sustainable design requirements. In both RFPs, similar language was used as design guidance. The following RFP guidance was provided for both projects:

> *The Contractor shall provide a Sustainable Design Plan with the goal of obtaining a U.S. Green Building Council LEED Rating System Certification. The plan shall provide a level of design acceptable to receive a LEED certified level.*

The RFPs also required a sustainable Design Plan be submitted with the Contractor's Technical Proposal and that a Sustainable Features Log (SFL) be updated throughout construction. This SFL is to describe sustainable features or products or systems, and record start and finish times for installation of these systems or products.

Guidance directing the facility siting, however, was considerably different for each project. In P-101, a 6.2-acre site was offered for design consideration. While bordered by wetlands and a paved road, building orientation and exact location was not fixed by the RFP documents. However, in P-036, the building footprint and parking facilities were fixed according to drawings provided in the RFP.

Another factor that was directly related to sustainable design development was the force protection/anti-terrorism consideration. The two concepts were combined in most RFP language discussing the design development criteria. This did not, however, appear to negatively impact or enhance the ability to achieve sustainable goals.

6.3.5. Interview Results and Analysis

The following two tables show the interview results from the NAVFAC PM and architect interviews.

Table 6-4. NAVFAC Project Manager Interview Results

Q #	Questions for Project Manager (NAVFAC)	Case Study P-101 YES/NO	Case Study P-036 YES/NO
(1)	(2)	(3)	(4)
1	Was a sustainable goal setting charrette conducted?	**No**	Yes
2	Were sustainable goals set in the planning phase?	**No**	Yes
3	Were performance standards used in RFP?	Yes	Yes
4	Was energy and day-lighting modeling performed in Planning phase?	**No**	Yes
5	Were the owners or building occupants educated or given an orientation to sustainable concepts and possible sustainable design opportunities?	**No**	**No**
6	Were performance standards used in specifications to guide designer (A/E#2) ?	Yes	Yes
7	Were additional funds added to project anticipating increased costs for sustainable design?	**No**	**No**
8	Was a sustainable champion assigned to the project, or did one emerge during the planning and programming phases?	**No**	Yes
9	Did you provide the A/E #2 with a LEED checklist with points that should be obtained?	Yes	Yes
10	Did the Project Manager have any LEED certification training?	Yes	**No**
11	Were any contracted experts (in sustainable design or development) used during the planning and programming phases?	?	Yes
12	Was explicit owner "buy-in" sought or achieved with related to sustainable goals?	Yes	Yes
13	Were sustainable goals prioritized in the Planning and Programming phases?	**No**	Yes
14	Were sustainable design considerations or elements accounted for in initial government estimate?	**No**	Yes

All questions were presented in a similar format. All questions were related to recommended processes identified by other government agencies that were also validated

by industry experts. A positive answer to any of these questions would indicate that one or more of the ICs were applied to these projects. The italicized question refers to an action that is required by NAVFAC policy.

Upon review, Project P-101 answered most questions negatively. Even the action required by NAVFAC policy in Question #2 was not completed. In Project P-036, 11 of 14 questions were answered affirmatively, with only Questions 5, 7, and 10 answered with a No.

By initial evaluation, Project P-036 used twice as many actions to achieve sustainable goals than did Project P-101. The assumption might be made that P-036 would achieve higher sustainability score than the other project. However, the interviews conducted with the architects yielded a much different perspective.

Table 6-5 displays the results from the architect interviews. Similar questions were asked with a *YES/NO* answer in columns 3 and 5. Then a follow-up question was posed, "If this action or process had been conducted in the planning and programming phase, would ***more*** or ***less*** constraint have been placed on the design. The assumption is that if more constraint is placed on the design by the RFP documents, the architect will have a more difficult task in achieving sustainable goals for a project."

Table 6-5. Architect Interview Results

Q #	Questions to Architect	Case Study P-101 Answer Yes/No	Case Study P-101 * Constraint on Design? More/Less	Case Study P-036 Answer Yes/No	Case Study P-036 * Constraint on Design? More/Less
(1)	(2)	(3)	(4)	(5)	(6)
1	Was a sustainable goal setting charrette conducted in the planning phase?	**No**		**No**	Less
2	Were the sustainable goals clearly stated in the RFP?	Yes	Less	Yes	
3	Were performance standards used in RFP?	Yes	Less	**No**	**More**
4	Were there any options for site location?	**No**	**More**	**No**	**More**
5	Were there any options for building orientation?	Yes	Less	**No**	**More**
6	Were energy and day-lighting modeling data made available (from concept design)?	Yes	Less	**No**	
7	Were the owners or building occupants educated or given an orientation to sustainable concepts and possible opportunities?	**No**		**No**	
8	Was there a sustainable champion on the Navy side or contracted on Navy behalf?	Yes	Less	**No**	
9	Were you provided with a LEED checklist with points that should be obtained?	Yes	**More**	Yes	**More**
10	Were Navy personnel (NAVFAC) knowledgeable in sustainable concepts? (specifically PM and contracting officer)	Yes	Less	**No**	**More**
11	Were any contracted experts (in sustainable design or development) used during the planning and programming phases?	**No**		Yes	
12	Were sustainable goals prioritized in the RFP?	**No**		**No**	
13	LEED Points Planned / Designed	26	26	26	24

* If Action posed in Question had been conducted, would more or less constraint have been imposed on Design?

The results from the architect interviews showed considerably different results from the questions asked to the NAVFAC project managers. While the NAVFAC project managers may have conducted the processes represented by their answers, the RFP

requirements used by the architect reflected a much different picture of the projects ability to achieve sustainable goals.

For P-036, there was a difference between the PM's answer and the architect's in Questions 1, 3, 5, 6, 8, and 12. This may indicate that the actions or processes taken in the planning and programming phases were not evident to the architect through either the RFP or during the design development interaction with the Navy PM. The architect indicated that more constraint was placed on the design by several issues listed below:

1. Performance Standards were not used by the RFP documents to indicated sustainable design requirements. In fact, prescriptive requirements were used to specify various materials and systems that prevented many other opportunities from being considered. Example: A specific broadloom carpet was specified in the RFP documents. This material was neither made from recycled sources nor was it low-VOC emitting. The color of the carpet effected lighting and paint color opportunities as well. *The ability to achieve sustainable design was reduced by the lack of performance standards used in the RFP.*

2. The facility siting was restricted to the existing building footprint. The existing building and parking lot was to be demolished and replaced by new structure and lot in the same place. However, the new plans required the building to be switched with the parking lot. So now the new building would be built where the old parking lot was and vice versa. This caused several basic problems. Utility and storm water systems servicing the site now had to completely demolished and rebuilt. The effect on function and building performance was not improved by relocating the building and resulted in greater site disturbance. *The inability for the architect to recommend an alternative building site (the original) created construction requirements that increased material, labor, time, cost and energy while decreasing ability to score additional 2 LEED points.*

3. When the architect (Question #12) was asked about the knowledge level of the NAVFAC project manager and contracting officer with respect to sustainable concepts, a negative response resulted. This was further explained to have impacted the project by preventing the design development from presenting sustainable design opportunities to the Navy project team.

Additional comments provided by the architect for P-036 are listed:

1. (Architect) Needed more freedom in building footprint location. Site could have been more effectively used and still met all function, mission and client requirements, as well, as force protection and anti-terrorism while increasing overall sustainability goals.
2. Life-cycle analysis did not seem to be a concern during the design development. First costs guided most decisions when alternative solutions were presented.

The number of LEED points required by the RFP is the minimum for certification - twenty-six. P-036 only reached 24 points at final design. The Navy conceded on two points during design development, stating that "Twenty-four would be close enough." Had some of these constraints on design not been a factor, this project could have easily achieved minimum goals and possibly much more. In this case, language in the RFP did not take advantage of and utilize the processes that had occurred in the planning and programming phases.

To the contrary, Project P-101 used less than half of the sustainable development processes that P-036 had used, and yet this project met sustainable design goals. When evaluating the architect's responses to questions, it is apparent that less constraint was placed on the design. Similar to the other project, the site location was fixed to a small area bordered by wetlands and a road, but exact building location and orientation was left

to the designer. This allowed achievement for 10 of 14 LEED points for the site selection. Had the building location been fixed by the client or Navy project team with out close evaluation, at least 4 of the points (5.1, 6.2., 7.1-2) would not have been attained.

Additional comments provided by the architect for P-101 are listed:

1. Other than minimum LEED score requirement, sustainable goals were not clarified in the RFP.
2. The client was completely unfamiliar with sustainable concepts and potential opportunities that may have improved the indoor environment and reduced the energy consumption of the facility.
3. NAVFAC project team was primarily focused on first cost issues.

Another constraint that both project architects identified was a LEED checklist that had been included in the RFPs. These checklists outlined points that were thought to be attainable or possible. The architects found this guidance to be a significant constraint. It precluded any consideration of systems that would have met building function requirements, as well as, achieve greater sustainability for the project.

6.3.6. Improvement Recommendations Validated by Case Studies

While issues not addressed by improvement recommendations and outside the scope for this research were brought into view, several recommended ICs were validated by the architect interviews. Processes addressed in questions (Q) 3, 4, 5, 9 and 10 were claimed to have placed more constraint on the design, thereby reducing the ability for the architect to achieve sustainable goals. To validate several improvement candidates (IC) the following questions, answers and related IC are discussed in detail:

- **Q #3 - Were performance standards used in RFP?** Project 036 notes that performance standards were not used the RFP. This question relates to IC # 13

from Table 5-1, to "*Develop Performance Standards in Initial Charrette.*" The lack of performance standards placed greater constraint on the design and thus may have negatively impacted the ability to meet sustainable goals.

- **Q #4 - Were there any options for site location?** Both projects note that there were no options for site location, however, on P-101, the architect had a 6.1 acre site to best utilize while P-036 was restricted to an exact building footprint. Both answered that the inability to consider different site locations reduced their ability to achieve sustainable goals. This question relates indirectly to IC# 14, "*Use Energy and Day-lighting modeling during building siting,*" in that had day-light modeling been conducted, another local site may have been more advantageous in achieving energy goals. However, depending on the building type, function and user requirements, this might rarely an option for the architect.

- **Q #5 - Were there any options for building orientation?** – P-036 answered that no options were provided for building orientation as well. Again, this directly relates to IC#14. Had energy modeling been conducted, the benefit may have been realized and addressed accordingly in the RFP documents.

- **Q #9 - Were you provided with a LEED checklist with points that should be obtained?** This question was evaluating the NAVFAC policy guidance (IC#16) to "*Identify Sustainable Design Strategies*" in the Planning Phase. This process was not supported by any agencies or corroborated by any experts. To implement this process, NAVFAC currently requires the RFP documents to include a filled-in LEED checklist to be given to the design-build contractor as a guide for design. This LEED checklist outlines specific strategies to be used to meet sustainable goals. However, both architects answered that this placed more constrain on design and therefore hindered their ability to achieve the projects' sustainable goals. This supports removal of IC#16 from the planning phase.

- **Q #10 - Were Navy personnel (NAVFAC) knowledgeable in sustainable concepts? (specifically PM and contracting officer)** P-036 answered that Navy personnel involved with project did not adequately understand sustainable development concepts and were not well versed in the LEED rating system. This question relates directly to ICs# 1 and 4 addressing training requirements. This lack of training caused a reduced ability to communicate available opportunities and constraints resulting in greater difficulty achieving sustainable goals.

6.3.7. Additional Issues Raised by Case Study Findings

The case study projects were used as potential means to show that if processes used by other government agencies were used during the Navy's acquisition process, sustainable development goals maybe easier to achieve on a consistent basis. While two case study projects provide insufficient proof that these improvement recommendations will enhance the Navy's acquisition process, they do offer some direct evidence revealing several areas in Navy facility acquisition that require improvement in order to meet NAVFAC sustainability goals. These major areas are; (1) Navy project team education, (2) Request for Proposal alignment, and (3) the communication of knowledge from one acquisition phase to the next

While one study showed a possible lack of sufficient education on part of the NAVFAC project management team, the other study revealed a PM with LEED certification. The latter project was more successful in achieving sustainable goals than was the prior. The Navy does not currently have a training program established to facilitate sustainable concept learning or LEED certification training. This may be a significant factor in achieving policy goals.

The RFPs evaluated seemed to use similar language in the front-end section referring to the requirement of a Sustainable Design Pan. Thereafter, prescriptive language and material specifications were used to a significant degree. Overall, only one of the RFPs was mostly performance based. This can be easily supported by the 600+ pages used for

P-036 and the 50 pages used for P-101. While one might have in fact used performance criteria more effectively than the other, neither effectively incorporated all previous sustainable development processes.

A lack of information flow from one acquisition phase to the next may have caused the RFP to be less effective. None of the interview questions addressed this potential problem, but this issue seemed to be evident by the references made when the PMs interviewed described the early stages of the project.

RFPs are not establishing design criteria that are aligned directly with NAVFAC policy. Policy states that, "sustainable concepts shall be incorporated to the fullest extent possible, considering mission, budget and client requirements" – not to the minimum attainment possible as demonstrated in these two case studies. Aiming for minimum LEED score instead of looking for available opportunities sets the entire project team up for failure – if the mark is missed by only a point, the project fails to meet policy mandates.

Even if all recommended sustainable development processes are used at the right time, it is still possible to fail in goal attainment if instruments used (such as RFPs) are not also aligned to achieve sustainable goals. To align the contract instruments, such as the RFP and other critical documents, personnel educated in sustainable concepts and the LEED rating system must also be responsible for project solicitation, contract formation and contractor award selection.

6.4. Summary

This chapter put the improvement candidates through three phases of evaluation. NAVFAC assessed feasibility for implementation. While none were eliminated by NAVFAC executives, several areas of concern were addressed. Then, industry experts were interviewed to identify corroboration between their expert opinions and the agency derived ICs. Finally, through case study analysis, five of the ICs (1, 4, 13, 14, and16)

were validated as being important processes that will help project teams achieve sustainable goals. Additionally, other issues observed during case study analysis may lead to further study in an attempt to improve RFP documents.

Chapter Seven: REVISED NAVFAC SUSTAINABLE ACQUISITION PROCESS MODEL

To meet the goals for this research and potentially add benefit to the continuing process improvement efforts at NAVFAC, the SAPM requires revision to show the improvement recommendations that can be applied. The SAPM provides the model framework for the new processes, as well as, the re-timed processes that already existed per NAVFAC policy.

8.1. Criteria for Application of ICs to Revised SAPM

Since all improvement candidates were filtered for applicability to NAVFAC prior to expert corroboration, the only existing criteria required is to establish which improvement recommendations would be propose in the revised SAPM.

The following criteria were used to select final improvements to be included in the revised SAPM:

- Process used must be applicable to the ten NAVFAC acquisition phases or to the acquisition process in general.
- Improvement must have been recommended by Agency interviewed
- Improvement must have been corroborated by at least one Expert
- Must be able to apply process with violating Federal Acquisition Regulation (FAR).
- The process must be identified by that agency as a process or action that assisted in achieving sustainable goals.

8.1. Improvement Recommendations for Revised Model

In all, eighteen improvement recommendations were identified, corroborated and passed all criteria for application to the SAPM for the ten phases of NAVFAC's acquisition process. Eleven of the eighteen occur in the Planning and Programming phases while the other seven occur at various points in the ACQ process. Two

improvement recommendations were already addressed by NAVFAC policy (ICs 32 and 35) and included in the original SAPM but were identified by agencies to have occurred in their respective planning phases.

In Table 7-1, the new and re-timed processes to be added to the revised SAPM are listed according to ACQ phase.

Table 7-1. Improvement Recommendations for Revised SAPM

Improvement Candidates (IC) Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	**Current NAVFAC Practice**	**Government Agency**			**Industry Experts**			**Case Study Results**		**Improvement Recommendation**	
		Per Policy Guidance	GGGC	PenRen	GSA	Rocky Mountain Institute	Ensar Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Planning / Programming Phases												
Ensure Project Manager has had LEED Training (accreditation not required)	1		X			X	X	X	N	Y	X	
Assign Sustainable Design Champion	3		X	X	X	X	X	X	Y	N	X	
Provide Timely Sustainable Design Training for Project Managers – project specific	4				X	X			N	N	X	
Conduct Goal Setting Charrette	5		X	X	X	X	X	X	Y	N	X	
Educate Owner and Occupants on Sustainable Concepts and Impact	6		X		X	X	X		N	N	X	
Involve Cx Agent in First Charrette	7				X	X			N	N		
Provide Sustainable Concepts Orientation to Key Leaders (Owners)	8				X		X	X	N	Y		
Use Sustainable Design Consultants	9		X	X	X	X	X	X	Y	N	X	
Ascertain Building Owner (President or Commander) Explicit Buy-in	12		X	X		X			Y	Y	X	
Develop Performance Standards in Initial Charrette	13		X			X			N	N	X	
Use Energy and Day-lighting Modeling	14		X	X	X	X	X	X	Y	N	X	
Concept Design Phase												
Use Sustainable Design Experts/Consultants for Strategy Formation	28			X			X			Y	X	

Table 7-1. (Continued)

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC#	Current NAVFAC Practice	Government Agency			Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Design Development Phase												
Design Charrette	34			X		X	X	X			X	
Perform Energy and Day-lighting Modeling	35	X			X	X	X					Move Forward to Planning Phase
Bidding and Award Phase												
Use Performance Standards in RPF and Contract	39		X	X	X	X	X	X		Y	X	
Use LEED Score Card Method for Proposal Evaluation	44		X		X	X					X	
Turnover Phase												
Reward Project Manager and Superiors for Achievement	56		X	X		X					X	
Other General Improvements												
Train Contracting Officers in Basic LEED principles	62			X	X		X				X	
Need Regionally Focused Sustainable Design Champions	66				X		X				X	

8.1. Revised SAPM

To complete the task of the revised model construction, the improvements identified in Table 7-1 are integrated into the SAPM at the major phase level – the Planning Phase. While the research supports the placement of the eleven newly identified processes in this major phase, the exact placement within this phase's sub-phases is not supported by any research or validation efforts conducted. In Figure 7-4, the approximate sub-phase steps are annotated depicting where the Planning Phase processes would be applied.

The following figure, Figure 7-3, presents the final recommendation to NAVFAC. Ten new processes were added and one existing process was deleted.

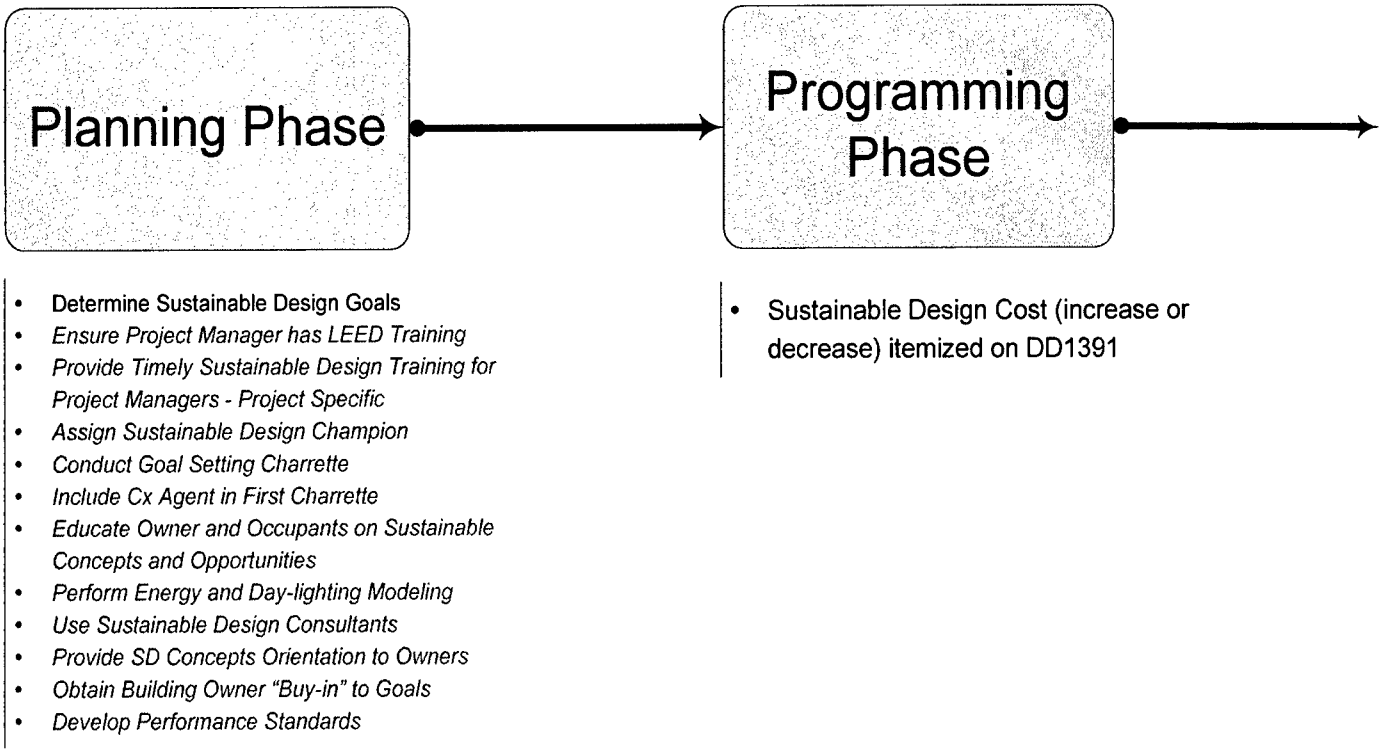

Figure 7-1. Proposed NAVFAC SAPM

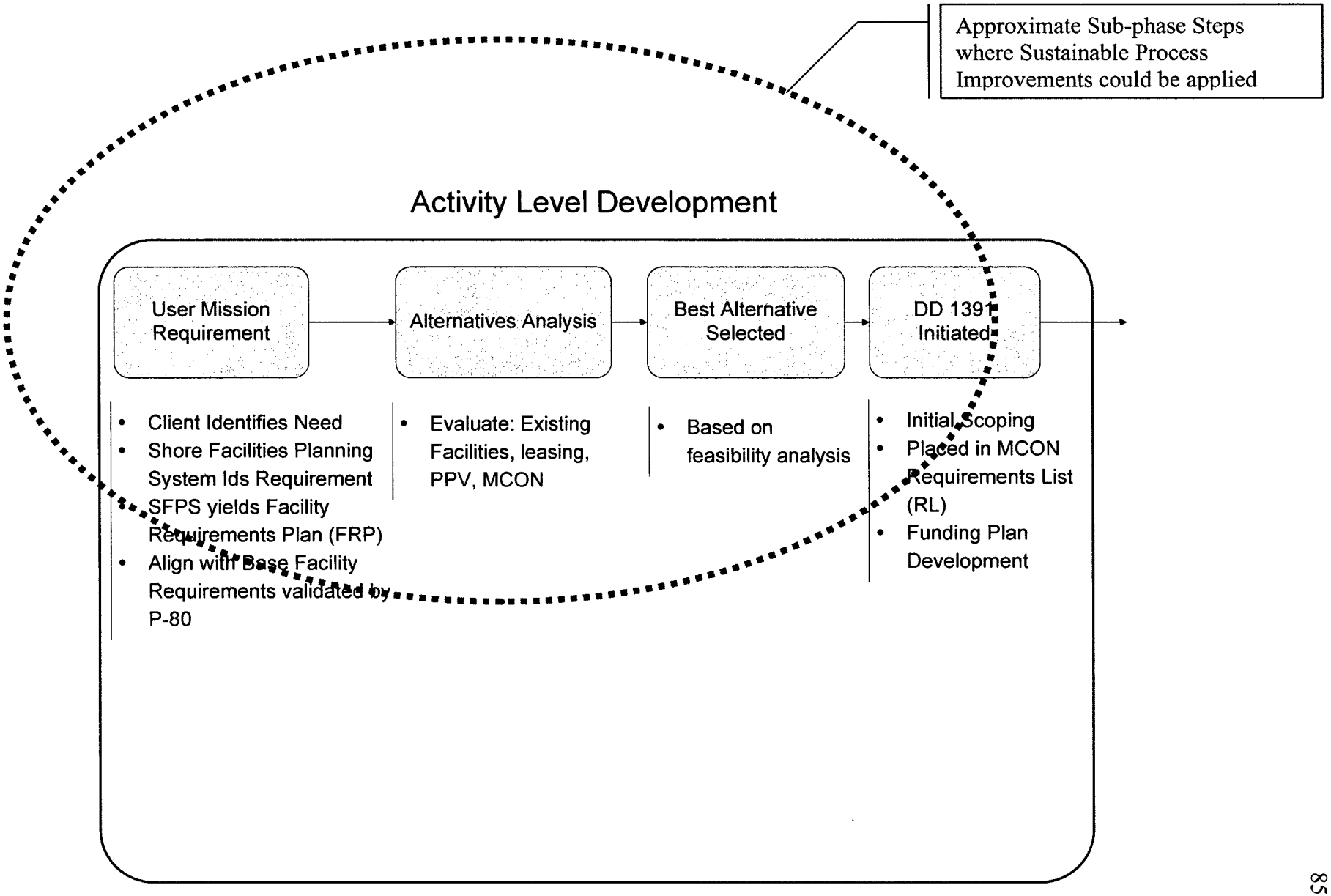

Figure 7-2. Application to Sub-Phase Steps

8.1. Summary

This chapter proposes the revised NAVFAC Sustainable Acquisition Model. To build this relatively simple model, three phases of improvement candidate refinement occurred. First, sixty-six ICs were identified from the agency and expert interviews (Appendix F). Twenty-one of the agency-identified ICs were corroborated by experts, but only 11 were located in the planning and programming phases, and thus, considered for application. Of these 11, the case study analysis yields strong evidence for 4 if these process improvements.

CHAPTER EIGHT: CONCLUSIONS

This chapter discusses the conclusion and contributions of this study to the design and construction industry, to other large organizations that acquire facilities, and directly to the Navy's sustainable development acquisition process. Actions that should be performed early in the planning phase of a building project are presented. Also, recommended areas for further research are identified – for the Navy and for the AEC industry in general.

This research met its four objectives. The first objective was to model the existing NAVFAC acquisition process. Once the environment was studied and understood, process improvements were identified for possible application to this model. The third objective focused on evaluating two case study projects for improvement candidate validation. Validation for the first four processes was accomplished. The final objective of utilizing the SAPM framework to propose new sustainable development process was completed – eleven processes that should be implemented by NAVFAC in their pursuit to meeting sustainable development goals are:

1. *Ensure Project Manager has LEED Training*
2. *Timely SD Training for Project Manager – Project Specific*
3. *Develop Performance Standards*
4. *Perform Energy and Day-lighting Modeling for Initial Siting Consideration*
5. *Assign Sustainable Design Champion*
6. *Provider Sustainable Design Orientation to Key Leaders*
7. *Educate Owner and Occupants on Sustainable Concepts and Opportunities*
8. *Use Sustainable Design Consultants*
9. *Conduct Goal Setting Charrette*
10. *Include Cx Agent in First Charrette*
11. *Obtain Building Owner "Buy-in" to Goals*

8.1. Contributions to Knowledge

This research has identified a sustainable development approach that may be used by any owner, contractor, or designer to achieve a project's sustainable goals. Large owner's such as other federal agencies, state governments, local municipalities, and large corporations that experience similar budget constraints could adopt these processes to enhance their success in achieving goals. Over 60 processes identified at various acquisition phases are presented in Appendix F. As these processes were refined to feasibly address NAVFAC's unique requirements, a short list of front-end considerations emerged that could be applicable to virtually any project seeking to achieve sustainable goals.

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8.2. Contributions to NAVFAC

Two significant contributions are presented to NAVFAC by this research. First, a model has been defined where one did not exist. The model presented in Chapter 4 defines the processes and sequential relationships between the major acquisition phases and sub-phases. While this model was eventually used as the framework for the SAPM, its original form can benefit any employee in NAVFAC who wants to understand the general process flow required for facility acquisition.

Second, that model was simplified to illustrate the results of this research – the sustainable process improvements. If these processes are implemented by NAVFAC policy, the ability to achieve sustainable goals in a consistent manner should increase. This will result in reduction of resource consumption and improve the environment in which our federal and military work force operates every day.

8.3. Sustainable Acquisition Model Limitations

The SAPM exists only to provide a framework that corresponds to NAVFAC's acquisition process. While the earliest phases are similar to almost any organization's process, the sub-

process required, timing of actions, funding sources are very different from most other organizations. Below are the major limitations for use of this model.

Limitations for SAPM:

- Model is very simplified. The sustainable acquisition model only shows the steps recommended to achieve greater sustainable design.

- Does not rank recommendations presented for the planning and programming phases. It shows each process or action as being equal in importance as the next when this is probably not the case.

- The SAPM does not identify legal funding sources (for Navy procurement) for new processes. Some of these processes make come at an increased expense, but budget considerations were not addressed.

- The SAPM does not contain a time reference. All processes appear to require equal time to complete while this is not the case. However, maximum time to complete any single process was considered and included in improvement candidate selection.

8.4. Directions for Future Research

Case Study research is needed to determine where and when the major problems are occurring that reduce the ability to achieve sustainable goals. The case studies in this research pointed out numerous problems in the NAVFAC RFP documentation that contradicted NAVFAC policy. In other words, the RFP language, in some cases, was not effective in achieving project goals. Recommendations on how to best address sustainable requirements in the RFP documents should be studied further.

Federal Acquisition Regulation restrictions that keep the federal sector from taking advantage of best design approaches used in commercial industry should be reviewed for revision. While executive orders are being passed to increase conservation efforts, legislative restrictions in the form of laws are preventing the federal sector from benefiting from industry practice.

8.5.Concluding Remarks

From observation throughout this research, the key to achieving sustainable goals does not appear to be entirely about process – but rather about people. The organization's culture has to promote or support champions – and champions at different levels will lead and innovate within their domain utilizing the processes identified and tools available. In many discussions with the various participants of this research, one commonality existed with almost all successful projects – somewhere in the midst of the process was a Champion leading the efforts. Processes alone never really achieved anything discussed in this research. However, the champion that used the processes and took advantage of these good practices achieved the sustainable goals.

The recommended processes within would be most effectively applied by the regional champions within NAVFAC. A culture that promotes championship and continuous training should be a primary focus for the NAVFAC organization in its pursuit to achieve greater sustainability.

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APPENDIX A: INTERVIEW QUESTIONS FOR GOVERNMENT AGENCIES

General Information

1. Interviewee Name
2. Company/Agency
3. Position
4. Years Experience in Green Design/Development
5. Case Projects referenced
6. Other personnel references

Questions about Programming/Planning (general within organization)

Defined as processes from Requirement Identification to Budget Approval

1. What are the major processes for you programming and planning phases?
2. What are the primary funding sources for your new facility projects?
3. When are SD goals set? To what level?
4. Who sets these goals?
5. Were consultants used during these phases? In-house experts in SD?
6. Is the use of energy, day-lighting models incorporated in your acquisition process? If so, when?
7. What professional skill sets (related to SD) are required to manage a project in these initial phases?
8. Was the client knowledgeable on SD concepts/opportunities? If not, how were they educated?
9. What resources (professional, technical) does GSA use on a LEED projects? What would you believe to be the best resources for initial planning of a LEED project based on your experiences?
10. Concerning SD decisions and planning, who are the team members for your projects.
11. Do your project mangers have LEED training? Or other related training?
12. What processes do you use to achieve your sustainable goals – other than already identified?
13. What types of project team members are involved at the various major acquisition phases?

Questions about Example or referenced Projects

1. Project write-ups, summaries available, published?
2. Unique ideas used on this project?
3. Initial sought versus final LEED rating?
4. Were building performance measures established?
5. Who were the key stakeholders during the initial stages? Who drove the project?
6. What methods were used to optimize site potential?
7. Who developed the funding documents, cost estimates for funding approval?
8. Key Lessons Learned?
9. Key factors to achieving LEED ratings goal?
10. What was the owner/builder relationship?

APPENDIX B: INTERVIEW QUESTIONS FOR INDUSTRY LEADERS

Interview Agenda for Expert Sources

Provide General Information about my research (in addition to into letter sent previously

My background
Scope of Research
Research and progress thus far, Discuss other Agency Processes
Describe NAVFAC organization and project

Questions about Sustainable Development

1. When should the SD goals be set? By whom ?
2. Concerning SD decisions and planning, who are the team members that should be involved
3. What type of education and level should the owner and project team (Navy) have under their belt at commencement of a project
4. What type of training plan should be implemented in the NAVFAC
5. How does an organization maintain focus on sustainable goals and not on the LEED point measurement system?
6. What resources should a team use on every project?
7. What Professional skill sets are needed within a project team?
8. What do you think about JIT education for project team?
9. What do you think about modeling the acquisition process to show types and timing of various sustainable processes to achieve green projects?
10. How many charrettes are required for a project?
11. Should available modeling tools always be used on projects? If so, at what time should these tools be used?
12. Should green consultants be called to assist with various phases? If so, at what phases should they be involved?

APPENDIX C: Raw Data from Government Agencies

Governor's Green Government Council

Interview notes from Jim Toothaker – recorded January 29, 2003 at the South Central Regional Office Building

Director
Bureau of Office Systems and Services
Department of Environmental Protection
And Part of Pennsylvania's Governor's Green Government Council

Projects Discussed

South Cambria Regional Office Building
Cambria Office Building
Norristown Office Building (85,000 sf)

Processes and Actions Used during Programming and Planning Phases

1. Use Design-build delivery method - GMP
2. Every project must have sustainable champion – can be involved at different levels – must have authority
3. Require mandatory pre-proposal conference to highlight sustainable features in RFP
4. Develop sustainability goals at outset – buy-in from chain of command
5. Prioritize sustainability goals in order to balance features with budget
6. Reward key managers, chain-of-command for achieving a sustainable buildings
7. Use HOK sustainable design checklist
8. Use LEED scorecard in proposal evaluations
9. Perform design charrettes led by outside experts in sustainable design
    a. Designers
    b. Owner
    c. Building occupants
    d. Engineers
    e. Sub-ktrs
    f. Suppliers
    g. University/Academia

h. Green building advocates

10. Develop performance standards including LEED criteria included in RFP
    a. Energy Budget req'ts
    b. AC tonnage limits
    c. Monitoring system req'ts
    d. IAQ requirements – humidity and temp limits, CO2, CO
    e. Electrical/Communications expansion capability
    f. Performance standard measuring plan – continuous Cx for building operators
11. Outline performance standards in initial Charrette
12. Use integrated design techniques
13. Use Energy modeling initially and update as design changes
14. Use day-lighting models to orientate building
15. Have landscape architects onboard from beginning
16. Get upper chain of command committed to project goals at outset
17. Focus on building functionality during initial planning phases
18. Educate building occupants
19. Project Manager must have solid understanding of LEED rating system
20. PM must understand performance standards and specs completely and thoroughly consider using sustainable performance factor (measured by LEED) required in proposal as method for selecting contractor – ex. Award will be based on Greenest Design.

Other Issues Discussed:

Leasing Processes in PA

Use of LEED score card in award selection criteria

Pentagon Renovation Program

Interview notes from Teresa Pohlman – written April 10, 2003 via conference call

Team Leader
Integrated Sustainable Design and Constructability Team
Pentagon Renovation Program
US Department of Defense

Projects Discussed

Pentagon Wedges 1,2-5
Pentagon Athletic Facility (PAT)
Remote Delivery Facility (RDF)
Metro Entrance Facility

Processes and Actions Used during Programming and Planning Phases

1. Pursue Buy-in from top management (owner) to specific goals with attached metrics
2. Use sustainable design experts in strategy formation
3. Use day-lighting and energy modeling prior to design development
4. Project managers need LEED based education, recommend certification
5. Conduct LCA during design development
6. set sustainable goals at earliest phase of project
7. Use sustainable development champion to review all phases of project, ensure right resources/tools used at right time \
8. Select design-build project delivery vehicle
9. Use performance requirements versus design specs
10. Use multiple design, constructability charrettes for initial planning and through design development
11. Use incentive fee based contracts
12. Integrate building functional/mission and force protection requirements with sustainable design goals or requirements. Recommend integrating with goals rather than hard set requirements.
13. Involve building owner, O & M personnel with sustainable goals and possible strategies being considered as early as possible for feedback. Especially important on existing buildings.
14. Develop recognition program from sustainable goal achievement
15. Contracting officers need basic sustainable practices education/orientation

General Services Administration

Interview notes from Don Horn, AIA – recorded January 29-30, 2003 at various GSA Office Building in Washington DC.

Director of Sustainable Design
Sustainable Design Program
GSA Public Buildings Service Office of Business Operations
US General Services Administration

Also interviewed:

Brian Peper, R.A.
Project Executive
GSA Public Buildings Service – National Capital Region

Charles Berry, P.E.
Project Manager, DC Service Center
GSA Public Buildings Service – National Capital Region

Carla Knode
Asset Manager
Portfolio Management Division
GSA Public Buildings Service – GSA Headquarters

Projects Discussed

Numerous Federal Courthouse Projects

Processes and Actions Used during Programming and Planning Phases

1. Use 2 sustainability charrettes to set project goals – during planning phase
    a. 1st to set goals
    b. 2nd to confirm goals with strategies to achieve before beginning formal design
2. Use design-build for sustainable building projects
3. Fund concept design with other than project funds
4. Use sustainable design champion assigned to each project
5. Use local (in-house) Sustainable design experts to review sustainable aspects of all projects in a region at the projects various stages. This person should be LEED certified for credential and receive continuous training to stay up to date.

6. Instate policy requiring certain level of sustainability (measured to LEED)
7. Include following stakeholders at charrettes:
    a. Tenants
    b. A/E, consultants
    c. GSA champion
    d. GSA project manager
    e. Contractors voice - if not contractor to be used
    f. Building operators
8. Increase construction budget from 5-7% to account for sustainable design features.
9. Train Lead contracting officers (regionally) in basic sustainability goals and how those may be addressed in the contract language
10. Use sustainability performance standards or specs for architects and engineers – by policy
11. Require at least one planning committee member to LEED accredited
12. Provide formal sustainable education to the client – GSA's Design Excellence Program
13. Establish project manager and team to see project from beginning to end
14. Include sustainable design elements in initial government estimate.
15. Policy should back up all requirements at every project phase to provide support to those pushing the sustainable issues
16. Require LEED scorecard in design proposals

Other Issues

GSA Leasing Program
GSA Design Excellence Program
GSA Process Mapping Efforts

APPENDIX D: RAW DATA FROM INDUSTRY LEADERS

Rocky Mountain Institute

Interview notes from Huston Eubank, AIA, CSI, CCS, LEED Accredited – recorded February 18, 2003 at the Rocky Mountain Institute Annex, Snowmass, CO

Principal of Green Design Services
Rocky Mountain Institute

Answers to Questions about Sustainable Development and Verification of Agency Processes

1. "Front end (planning phase) is make or break, concentrate on the front end."
2. Need a process
3. Educate project managers
4. Buy-in from owners on entire planning phases
5. Educate owners on sustainable concepts
6. Combine mission, force protection and sustainability
7. JIT education for project managers initially – absolutely
8. Set goal to learn sustainable design processes in-house – training program for project managers (2-4 years)
9. Set-up division training programs to develop sustainable culture for long term "good design" training as technology and methods change and improve
10. Charrette is a way to build consensus amongst a large group of people in a quick way."
11. During charrettes, get the participants involved
12. Use a charrette for every project – every project is unique, and requires unique consideration
13. Charrette at initial requirements assessment, then at concept design, then during design development for course corrections (check performance target and metrics)

14. Involve cx agent in first charrette and then conduct peer reviews during design development and then after turnover.
15. Someone needs to be tracking green measures and sustainable goals.
16. Use performance specs for sustainable design
17. Use design-build
18. Sustainable model is a very worthwhile tool, useful for demonstrating how to apply the sustainable process
19. "Don't become so process focused that you lose sight of what you are really trying to achieve."
20. Need a visioning statement that this isn't about the score, it's about the greater goals.
21. Set performance standards, absolute standards – energy, or resources per building sqft
22. Use LEED as tool to track towards meeting absolute standards
23. Ratchet standards up as goals become easier to meet.
24. "Based on the energy that it took to build the building, you should try to re-coupe that same energy over the life of the building" –Erin Sanders, possible benchmark of ultimate sustainability.
25. Set targets in reach, but always stretch the limits…to continue becoming more sustainable
26. Devise policy to continually ratchet up standards
27. "I am fascinated by what you are doing." - Huston Eubank

ENSAR Group, Inc.

Interview notes from Gregory Franta – recorded February 20, 2003 at the Rocky Mountain Institute Annex, Snowmass, CO

Lead Architect, President
ENSAR Group

Also, in attendance:
Jason Hainline
Environmental Design Consultant
ENSAR Group

Answers to Questions about Sustainable Development and Verification of Agency Processes

1. Avoid preconceived notion of building concept until concept design phase.
2. Started training w/ military since 1981
3. Has conducted sustainability training with federal agencies since mid 90s
4. Involved directly with Greening the Pentagon, White House, Served as AIA Chairman
5. Extensive charrette services with military projects
6. Teamed with RMI for training at NAVFAC (w/Emmons)
7. Participated in GL BEQ design process
8. Use design-build for green projects aimed to achieve LEED certification
9. Need a local champion
10. Need a project champion
11. Focused on greening RFPs – Performance specs vice prescriptive specs
12. 3 day training course – for federal project managers design managers
13. Need a comprehensive training program - internal approach for contract specialists, project managers, ROICCs

14. Consultants who are experts in sustainable development and green design should be brought in at different phase of planning and design. Unless, of course, the in-house ability has been developed to a point where sustainable goals are being achieved and strategies are being implemented.
15. Need training approach, level of awareness (1 hour consultation) for base commanders (or other top brass) that addresses sustainable policy, opportunities, and specific issues for a project under their command
16. Set lowest standard acceptable for goals, set minimum standards – related directly to specific criteria (VOC, water usage, energy, IAQ, etc.)
17. *"Navy is ahead of other services and private practice in some areas of sustainable development"*
18. *"I think selecting teams that have that have green experience is critical"*
19. Project managers need to be LEED accredited professional, this level of education is the minimum and continued education is required to continue to take advantage of emerging technology and new developments
20. Use multiple design charrettes
21. Provide online (sustainable) courses for all levels or participants of government project teams (online example, Solar International)
22. Smaller, low-key charrettes up front (initial planning step), then one with facility owner and operators to gather ideas, foster early buy-in,
23. Various modeling tools must be used during concept development

Natural Logic, Inc.

Interview notes from Bill Reed, AIA – recorded March 4, 2003 via phone conference

Vice President

Natural Logic, Inc.

Comments on Processes and Actions Identified from other government agencies

1. Need performance benchmarks
2. Main decision maker (one who holds the money) needs to understand sustainable, policy, sustainable / integrated design concepts and benefits, and be able to understand the sustainable goals set and be part of that decision.
3. Need key leader buy-in
4. Need documented framework for sustainable process implementation
5. need a team planning session to plan all remaining project team meetings – set specific goals and deliverable for each phase of project
6. Need goal setting meeting
7. Develop rfp language to address performance goals rather than specify elements
8. Conduct energy modeling in initial planning phase and then as necessary to check various design changes
9. Train contractor on sustainable strategies incorporated and constructability issues related
10. Develop and test performance monitoring system
11. Use strategic sustainable planning consultants – look at master planned development in addition to building site
12. Use multiple charrettes or team meetings that evaluate options concerning sustainability or integrated design as design planning progresses
13. Provide education to Project Managers, contracting officers and Navy construction managers at the appropriate level in order to achieve goals set
14. Conduct thorough materials research
15. Conduct LCA to leverage all downstream benefits
16. Set performance standards

APPENDIX E: RESEARCH TRAVEL MEMORANDUM AND NOTES

February 23, 2003

From: Erin Sanders
Mike Pulaski

To: Dr. David Riley
Dr. Michael Horman

Subj: TRIP REPORT – THESIS RESEARCH

Encl: (1) Brochure – Institute for the Built Environment, CSU
(2) Course Description – Sustainable Practices

1. Trip Purpose:

Upon completion of the Graduate Competition in Reno, Nevada, three research interviews were completed from February 18-21, 2003. Interviews were scheduled with Rocky Mountain Institute (RMI) in Snowmass, CO, ENSAR Group, Inc in Boulder, CO, and Colorado State University (CSU) at Fort Collins, CO. Current research agendas and future collaboration possibilities were discussed with all three institutions.

These interviews were an integral step in the completion of the research phase for Erin Sanders. Used as a 'Litmus Test' for previous research findings, RMI and ENSAR were presented results for validation and/or additional insight to research topic. Topics of current sustainable development research at CSU were investigated as well.

Mike Pulaski presented his background and current research direction to RMI and ENSAR as well. However, he proposed that adding the 'Constructability' component to the design charrette in order to achieve a greater sustainable and integrated design was essential – all three institutions interested.

2. Highlights:

Rocky Mountain Institute - Met with Huston Eubank on Tuesday, 18 Feb 2002 at the RMI Annex in Old Snowmass Village, CO.

Erin's research

- Explained background, purpose
- Discussed results thus far'
- Received validation and recommendations, including;
    - Front end design loading
    - Charrette timing
    - Multiple Charrettes
    - Interactive briefing
    - Team leader training/education – Build in-house NAVFAC teams
    - Creative Funding sources for consultant work –initial

Mike's research

- Constructability sources id
    - UK – High Tech Architecture
    - Norman Foster - Lecturer

        - Hong Kong/Shanghi Bank
    - Façade Engineers – Lessons Learned applied to constructability
    - Designing for Deconstruction
    - Pentagon Discussion
        - Wedge 3 Charrette – RMI involved, very interested in participating
    - Partnering Possibility with PSU on constructablity
    - Integrating constructability with RMI design charrettes
    - 4-6 week Visiting Scholar to RMI (Jan-Feb)
- CA high performance school website. (IAQ testing protocol) – contracting methodology for testing.
- NSF Proposal
    - RMI declined by NSF due to lacking academic backing
    - Interested in partnering with PSU in NSF study
- Performance Based Fee's
    - Payment as a percentage of savings (energy, baseline…)

Items Received:

- 200 RMI Case Study CD
- RMI Environmental Design Charrette Book

ENSAR Group, INC - Met with Greg Franta (and Jason Hainline) at ENSAR office building 20 Feb 2003 in Boulder, CO

Erin's Research

- Training Programs
    - Online Course work – Solar Design example
    - Client Education
    - Base Commander/Leadership Education
    - Project wide training
        - Different levels of detail of education at different points
- Charrette Timing
    - Identify opportunities not constraints
- Performance specs with minimum green standards
    - Must meet particular credits
- Need to send us "making the business case" draft

Mikes Research

- BEQ Great Lakes Project – Constructabilty reviews by ktr
- Interested in partnering to enhance constructability input
- Interested in Pentagon case study for High Performance Buildings

Items Received

- CD – Case Studies (Ft. Carson Charrette report, greening the white house, pentagon, Marine Corps Base, Hawaii)

Colorado State University

Met with Brian Dunbar (Director of Institute for the Built Environment) and Katherine Pettit (Grad student)

Discussed PSU research and CSU research

- Brian ran through his Greening the Classroom presentation
  - Result of a CSU grad course
- Sustainable Practices, Summer Study Tour
  - 10 day course open to anyone (encourage participation from outside CSU)
  - Joint Course with Miami University
- Grad Studies (about 15 students
  - Initial cost
  - Embodied Energy and BEES
  - Evaluate 39 LEED certified buildings (document design process, cost, schedule, design Fee's) – Similar to what Bill Reed is interested in.
  - Bio Mimicry
  - Design Build and Sustainability
  - Life Cycle cost
  - Diffusion of Green Building
- Interested in USGBC workshop
- Wants to incorporate more research into USGBC.
- Interested in Partnering with PSU, sharing class notes, developing grad level courses – collaborating
- Discussed PACE
- Discussed PSU research. (Straw bale housing, Role of Contractor, NAVY work,
- Canada Research/ Academic Research.

Items Received

- Brochure – Institute for the Built Environment
- Sustainable Practices, Course description
- CSU Green Classrooms Paper

3. <u>Action Items or Recommendations</u>:

- Send copies of research results to RMI, ENSAR and CSU (Erin Sanders / Mike Pulaski)
- Plan to send (3+) Penn State graduate students and (1) Faculty to SUSTAINABLE PRACTICES course; Currently a joint venture between CSU and Miami University. (AE Faculty)
- Apply for 4-6 week Visiting Scholar Program and RMI, (Mike Pulaski)

4. <u>Opinions</u>:

All interviewees were extremely interested in the efforts at Penn State. We feel that these institutions revere our education and research interests as genuine and useful. All three were interested working together and indicated that their programs would benefit from collaboration with Penn State.

This is important considering that RMI works with relatively few other institutions. RMI is focused on cutting edge sustainable development. Huston Eubank, with RMI, was impressed with depth of understanding and familiarization that Mike and Erin possessed. Future work with this industry leader seems very probable.

While ENSAR is a profiting corporation, their research efforts consist mainly of case study analysis in order to make a business case for potential clients as well as for general marketing purposes. ENSAR is also interested in the potential improvements posed by adding the constructability aspect to its design charrettes.

Contacts List:

Rocky Mountain Institute, RMI
Huston Eubank – Leader for Green Development Services, (970) 927-3851
Bill Browning – Author of, Green Development, (970) 927-3851

ENSAR Group, Inc.
Gregory Franta – Principal Architect, (303) 449-5226
Jason Hainline – Enviro. Design Consultant, (303) 449-5226

Colorado State University
Dr. Brian Dunbar – Director, Institute for the Built Environment, (970) 491-5041
Katherine Pettit – Research Student, (970) 491-5041

APPENDIX F: IMPROVEMENT CANDIDATE MATRIX FOR ALL ACQUISITION PHASES

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	Current NAVFAC Practice	Government Agency			Improve-ment Candidate	Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Planning Phase													
Ensure Project Manager has had LEED Training (accreditation not required)	1		X			Y	X	X	X	N	Y	X	
Assign (1) LEED accredited member (in-house) to planning team	2				X	Y				N	Y		
Assign Sustainable Design Champion	3		X	X	X	Y	X	X	X	Y	N	X	
Provide Timely Sustainable Design Training for Project Managers - project specific	4				X	Y	X			N	N		
Conduct Goal Setting Charrette	5		X	X	X	Y	X	X	X	Y	N	X	
Educate Owner and Occupants on Sustainable Concepts and Impact	6		X		X	Y	X	X		N	N	X	
Involve Cx Agent in first Charrette	7				X	Y	X			N	N		
Provide Sustainable Concepts Orientation to Key Leaders (Owners)	8				X	Y		X	X	N	Y		
Use Sustainable Design Consultants	9		X	X	X	Y	X	X	X	Y	N	X	
Determine Sustainable Goals	10	X	X	X	X	Y	X	X	X	Y	N		
Prioritize Sustainable Goals	11		X			Y				Y	N		
Ascertain Building Owner (President or Commander) Explicit Buy-in	12		X	X		Y	X			Y	Y	X	
Develop Performance Standards in Initial Charrette	13		X			Y	X			N	N	X	
Use Energy and Day-lighting Modeling during Siting	14		X	X	X	Y	X	X	X	Y	N		
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	15			X	X	Y				N	N		
Identify Sustainable Design Strategies	16	X				Y				Y	N		

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Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	Current NAVFAC Practice	Government Agency			Improve-ment Candidate	Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Programming Phase													
Include sustainable design elements in initial Government Estimate	17				X	Y				N	N		
Allow 5-7% Project Growth for Sustainable Design	18				X	N				N	N		
Itemize Additional Sustainable Design Costs on DD1391 Form	19	X				Y				N	N		
A/E Selection Phase													
Place LEED accredited person on selection board	20	X											
Educate board personnel on SD concepts	21	X											
Develop FBO Announcement requiring SD experience	22	X											
Use Sustainable Design Performance Standards for A/E Award	23		X										
A/E Contract Phase													
Develop SOW for A/E services for SD goals and strategies	24	X								Y	Y		

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	Current NAVFAC Practice	Government Agency			Improve-ment Candidate	Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Concept Design Phase													
Sustainable Goal Review	25						X	X					
Fund Concept Design w/other than Project Funds	26				X								
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	27				X								
Use Sustainable Design Experts/Consultants for Strategy Formation	28			X				X			Y	X	
Design Charrette - Check Goals and Strategy Alignment	29	X	X	X	X		X	X	X				
Begin SD Report	30	X											
Use HOK Sustainable Design Checklist	31		X										
Set Sustainable Goals	32	X								Y	Y		**Move Forward**
Use Integrated Design Techniques	33								X				

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	Current NAVFAC Practice	Government Agency			Improve-ment Candidate	Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Design Development Phase													
Design Charrette	34			X			X	X	X			X	
Perform Energy and Day-lighting Modeling	35	X					X	X					**Move Forward**
Perform Life-Cycle Analysis to evaluate all VE options	36			X							Y		
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	37				X								
Update SD Report	38	X											
Bidding and Award Phase													
Use Performance Standards in RPF and Contract	39		X	X	X		X	X	X		Y	X	
Design Build with GMP Type Contract	40		X										
Use Incentive Fee based Contracts	41			X							N		
Contractors attend Pre-proposal conference	42		X										
Pre-bid conference to address SD Goals	43	X											
Use LEED Score Card Method for Proposal Evaluation	44		X		X		X					X	
Design Build	45		X	X	X		X	X	X		Y		
Award to Proposal with Greatest LEED Score	46		X										
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	47				X								

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	Current NAVFAC Practice	Government Agency			Improve-ment Candidate	Industry Experts			Case Study Results		Improvement Recommendations	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Design and Construction Phase													
Educate ROICC/KTR on SD Goals	48	X											
Establish waste management program	49	X											
Maintain SD Report	50	X											
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	51				X								
Commissioning Phase													
Cx Agent Verify Sustainable strategies incorporate successfully during construction	52	X											
Validate proposed means of system performance measurement	53	X											
Assign Independent Experts (In-house) for Sustainable Design / Peer Review	54				X								
Turnover Phase													
Educate Building Occupants on Sustainable Features Built	55	X	X										
Reward Project Manager and Superiors for Achievement	56		X	X			X					X	
Periodically evaluate performance	57	X											

Potential Improvements Categorized by Phase *(per NAVFAC Acquisition Model)*	IC #	**Current NAVFAC Practice**	**Government Agency**			**Improve-ment Candidate**	**Industry Experts**			**Case Study Results**		**Improvement Recommendations**	
		Per Policy Guidance	GGGC	PenRen	GSA	Yes/No	Rocky Mountain Institute	ENSAR Group	Natural Logic	P-036	P-101	New Process	Change Process Timing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Other General Improvements													
Instate Organization Policy Requiring LEED Rating Minimum Score	58		**N**		**X**								
Develop In-house sustainable design expertise through in-house training programs	59						**X**	**X**					
Set up Online Sustainability Lectures / Classrooms	60							**X**					
Project Managers require LEED based training	61			**X**			**X**	**X**					
Train Contracting Officers in Basic LEED principles	62			**X**	**X**			**X**				**X**	
Sustainable Design Policy should provide support to Project Managers	63				**X**								
Need documented process for implementing sustainable design	64						**X**						
Continually revise policy to increase standards as technology advances	65						**X**						
Need Regionally Focused Sustainable Design Champions	66				**X**			**X**				**X**	

defined sustainability as " Design and construction that improves energy conservation, increases use of renewable energy sources, reduces toxic substances in buildings, improves indoor air quality, uses recycled materials for construction, reduces construction waste, and creates a healthy environment for building occupants." (1998)

Since early 1999, Naval Facilities Engineering Command (NAVFAC) has been seeking to streamline this process in order to construct the most energy efficient and productive work environments available for its clients. These clients consist of the leadership of hundreds of commands within the numerous communities in the Navy, and in some cases, the Air Force.

While certain regions within NAVFAC have experienced success in achieving sustainable design, the vast majority of the organization is not uniformly configured to implement available sustainable strategies and technologies. Before NAVFAC is able to effectively advance with this implementation in a logical and efficient manner, it would be useful if the lessons learned from other industries were reviewed and applied to the current design and construction processes. While drastic process changes to the existing NAVFAC building practices would not be an effective approach, incremental process changes through education of sustainable building techniques led by a knowledgeable team would contribute to a continuing effort to be environmental stewards and proactive leaders in the construction industry.

It is widely believed in the construction industry that an integrated approach must be used to achieve an effective sustainable building design. There is limited research concerning best methods to organize green design teams within a cooperative environment. And within an ultra-structured funding approval system such as that of the Defense Department, there is no guidance for sustainable design implementation at the earliest phases of a military construction (MILCON) level project. A MILCON level project is one that exceeds $500,000 in total cost and must be approved by Congress.